Input-Output Analyses of Fiscal Policy in Ontario

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Council

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Foreword

Because of the diversity of effects of government policy, it is desirable to be able to obtain disaggregated analyses of changes in governmental fiscal policy. Input-output models provide a technique for making such disaggregated analysis; such models are being increasingly used for this purpose.

A description of the nature of input-output models together with an evaluation of their value and limitations is provided in an introductory essay. Input-output models are based on some important simplifying assumptions. These assumptions make tractable the numerical analysis required to obtain solutions of disaggregated models, but require that users take care in interpreting the validity of conclusions reached using input-output models.

The basic input-output data for Ontario was originally obtained by the Ministry of Treasury, Economics,and Intergovernmental Affairs and published in the 1972 Ontario Economic Review. An adjusted and improved version, prepared by the Econometric Research Division of the Ministry, is published in Data Appendix A.

The monograph is divided into two parts. Part I contains several important extensions of input-output data which are required for analyses of the disaggregated effect of Ontario fiscal policy. These include: (1) the construction of detailed estimates of trade flows between Ontario and the rest of Canada, done by Boadway and Treddenick, (2) estimation of the industrial composition of government expenditures, done by Kubursi; and (3) estimation of the regional distribution of value-added and wage bills of each industry, also done by Kubursi.

In Part II, the data are used in several analyses of the effect of Ontario government fiscal policy. One, by Boadway and Treddenick, analyzes the short-run effect of alternative tax changes on industry output and employment. This study indicates that tax changes with equal revenue implications may have substantially different short-run employment impacts, and should motivate further work aimed at verifying the study's conclusions. A second, by Kubursi, analyzes the regional impact of different expenditure programs. This study indicates that virtually all Ontario government programs have had the effect of increasing the concentration of employment in the Toronto-centered region and of increasing regional income disparities. A third paper, also by Kubursi, focusses on evaluating the efficiency of Ontario government expenditures.

The papers in this study rest on assumptions which are necessarily restrictive; their conclusions hence should be regarded as first approximations. Morever, these conclusions are in some cases highly sensitive to the assumptions made by the authors, and hence may not be validated by more detailed further work. Nevertheless, the conclusions are provocative and should motivate further work aimed at generating an improved data base with which more accurate disaggregated policy models can be constructed.

The papers presented in this volume were not done as part of an integrated program, and represent separate contributions to the use of input-output models for policy analysis purposes. They are, nevertheless, complementary contributions that may be integrated in the course of further research applications of such models.

The results of the papers are summarized and discussed in subsequent chapters. Additional detail are presented separately in the form of data appendices, available from the Ontario Economic Council on request.

In editing this volume, I am indebted to Colin Hindle and Don Dawson for constructive suggestions, and to the referees of

the papers and of this volume for their comments. I am also indebted to the authors for their willingness and cooperation.

Professors Boadway and Treddenick have indicated that they would particularly like to thank Frank Penton, Roger Reid, and Peter Tracey, former graduate students at Queen's University, for their assistance in gathering data and programming their computations and to Mrs. Gerda Pennock who efficiently typed the manuscript.

Toronto

June 1977 John Bossons

Chapter 1

The Value of Input-Output Models

J. Bossons

In analyzing government policies, a policymaker is inevitably concerned with the effects of a policy change on individual households, industries, firms, and regions. Policy changes are relatively abstract when viewed in terms of their aggregate implications, and estimates of aggregate effects are consequently not very relevant to policymakers interested in the political implications of a proposed change. Political implications reflect the concrete effects of a policy or policy change on particular individuals. It is consequently highly desirable to estimate what the effects of a policy will be on a disaggregated basis that focusses on effects on particular industries or regions.

The input-output analyses reported in this volume are steps in the direction of providing disaggregated models of the effects of policy change. They are oriented to producing estimates of the average effects of policies or policy changes on industries or on regions, thus providing disaggregation to the level of regional or industrial aggregates. In addition, by disaggregating the analysis to this extent, input-output models can provide a basis for obtaining estimates of the aggregate effect of policies or policy changes on total employment and other aggregate variables which are potentially more accurate than if estimated wholly at an aggregate level.

The motivation for using input-output models is thus both an interest in disaggregated forecasts and a potential improvement in the accuracy of aggregated forecasts. In this introductory essay the structure of input-output models is described and evaluated.

1. What are input-output models?

In order to analyze the impact of a policy change, it is necessary to follow its effects through the economy. Suppose as an example that taxes of alcoholic beverages sold in Ontario are increased by 25 percent. The immediate effects of this tax increase will be a change in the allocation of consumer budgets that will result in both a decrease in the consumption of alcoholic beverages and a decrease in total real consumption. The extent of the decrease in consumers' purchases of alcoholic beverages can be forecast using estimates of the 'elasticity' of such purchases with respect to the price of alcoholic beverages ("elasticity" being defined as the ratio of percentage change in real consumption to the percentage change in price). The extent and direction of the change in consumers' purchases of other items similarily can be forecast by estimating the responsiveness of purchases of other items of consumption to the change in the price of alcoholic beverages and to the resultant change in consumers' real disposable income.

The type of analysis described in the foregoing paragraph is aimed at predicting the direct impact of the policy change (in this case the tax on alcoholic beverages) on the consumption behaviour of households. Though disaggregated, it is not input-output analysis, in that it is concerned only with predicting the direct impact of the policy.

Input-output analysis is concerned with measuring the indirect as well as direct effects of a policy change. In the case of the preceding example, let us simplify the direct impact by assuming (in this case, incorrectly) that the price elasticity of demand for alcoholic beverages is unity and that the policy change has no direct effect on consumers' demand for any other products. In this highly simplified case, the only direct effect of the tax is to reduce consumption in Ontario of alcoholic beverages.

The indirect effects within Ontario of this change in consumption are the results of the responses of domestic beverage producers to the change in aggregate demand for their products. These responses may include any or all of the following: (a) reducing employment, (b) reducing investments in capital, and (c) reducing the purchase of materials. Each of these responses will trigger further adjustments by other decision makers. A reduction in employment will cause a reduction in the aggregate disposable income of consumers and hence engender a decline in consumer demand for all consumer goods, including but not limited to alcoholic beverages. The immediate effect of a reduction in capital investment would presumably be a decline in sales by Ontario producers of capital goods along with a decrease in imports of these goods into Ontario. This in turn would engender reductions in output and in employment by capital goods producers in Ontario. The effect of a reduction in purchases of materials needed in the production of alcoholic beverages will similarly be a reduction in output and employment in the industries in which these materials are produced.

These interrelated effects are shown in a simplified example in Figure 1. In this example, it is assumed that there are only three industries and that there are no changes in real investment induced by the changes in output predicted by the model. It is assumed that an initial policy change has a direct effect only on the demand for output of a single industry ("industry 1"), and that there is only one material output used by this industry. Even so, the number of feedback effects is substantial.

The example shown in Figure 1 assumes that the production of output in industry 1 requires the use of materials produced by another industry ("industry 2"). It further assumes that industry 2 production requires materials produced both by the first industry and by another industry ("industry 3"), which in turn is assumed to use materials produced by the first two.

These linkages are shown by the solid arrows in Figure 1, as are the employment effects of production changes in each industry. Additional potential impacts of production changes in each industry on the demand for imported materials are also shown by solid arrows.

These linkages imply feedback effects on industry 1 as well as on other industries. The interrelatedness of industries implies that there will be a sequence of adjustments (including further adjustments by the first industry) in response to the effects of a change in industry 1 output resulting from a policy-induced change in demand for that industry's output.

The linkages are further complicated by the potential effects on aggregate demand of changes in industrial employment. A reduction in employment will reduce consumers' income and hence cause aggregate consumption to be reduced; this will have a further impact on demand for the output of each industry. These aggregate demand linkages are shown by the dashed lines in Figure 1.

Conceptually, there is an infinite sequence of indirect adjustments that will occur in response to the direct effects of a policy change, with each adjustment triggering a subsequent adjustment. As with most infinite sequences, the adjustments get progressively smaller, so that the process tends fairly quickly to a limit. Input-output models are in essence designed to calculate the cumulative effects of all adjustments as the economy reaches the end of the sequence of indirect adjustments that are required.[1]

The use of the phrase "input-output" to describe these models reflects their strong orientation to material flows data. The production of each good or service - output of

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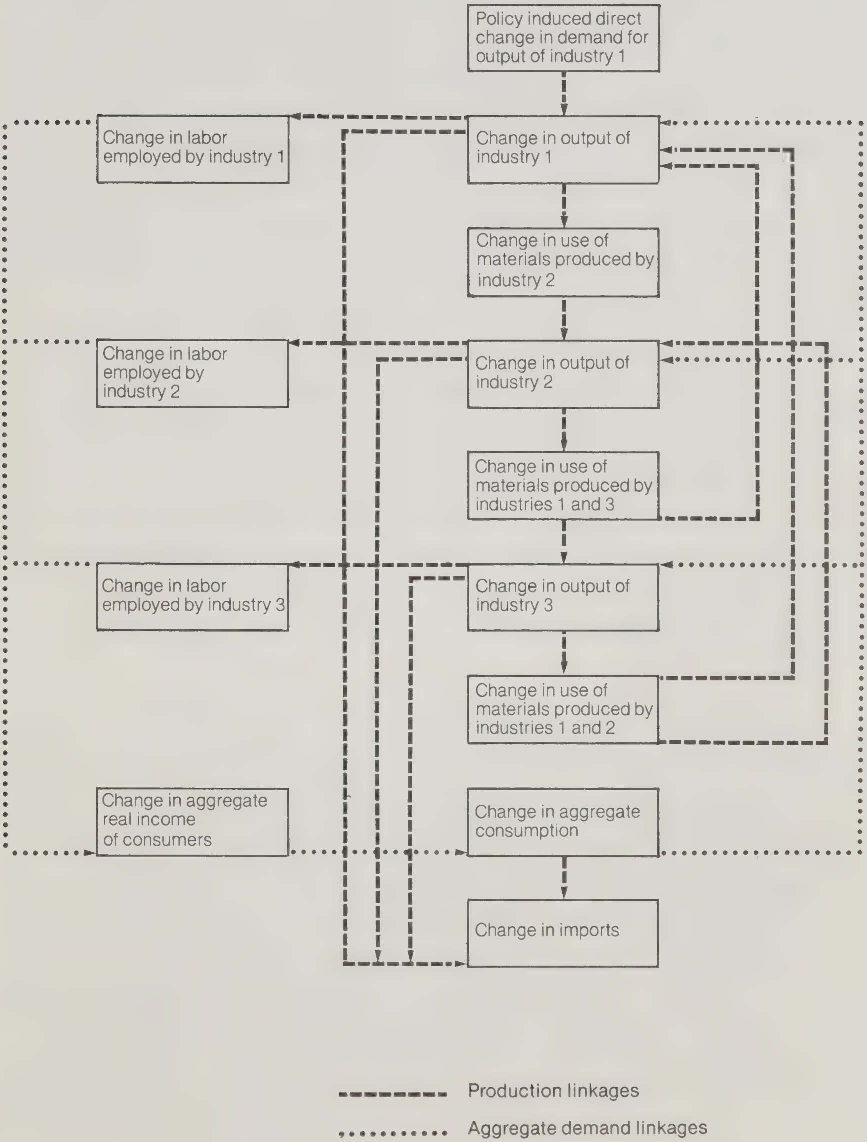
[1] The sequence of adjustments and implications of convergence are described more formally in the Technical Appendix to this chapter.

FIGURE 1; SIMPLIFIED EXAMPLE OF INTERRELATIONSHIPS

(arrow denotes direction of influence)



producers - requires a certain amount of inputs of goods and services produced by other firms in the economy. The relationship between the inputs used and the amount of output of the good produced can be quantitatively measured using data on production and on purchases of materials (exclusive of purchases reflected in changes in inventories of material). Input-output analysis typically extrapolates from this data by assuming that the same ratios of inputs to output will occur at any scale of production of the output good.

Needless to say, material flow relationships constitute only one part of the relationships which have to be modelled in order to construct a complete model of the adjustments which will be triggered by the direct effects of a policy change. Nevertheless, the "input-output" label is typically used to describe any disaggregated model in which material flow relationships are an important component and in which a change in the output of an industry is assumed to generate proportionate changes in all material inputs. This assumption of linearity or proportionality is often extended to include a linear relationship between other inputs and the output of each industry (as for example in assuming that the demand for labour in each industry is proportional to the output of each industry).

Obviously, the motivation for input-output models is the desire to specify models that are disaggregated to the level of industry aggregates. Input-output models are a particular form of such models in which the relationships between inputs and outputs constitute an important portion of the model. The assumption that such relationships are linear is both an important simplification and a restriction. The advantage of the simplification is that the calculations required to solve the model are made much more tractable. The disadvantage is of course that the assumption may be wrong, and that this error may matter.

2. The structure of input-output models

In the previous section, input-output models have been described in very general terms. In this section, they will be described in somewhat more detail in the form in which they are used in the analyses reported in this volume. The restrictions of these models will also be discussed.

Since input-output models have been defined as models in which material flow relationships among industry aggregate production rates are an important component of the model, these will be discussed first. This will first be done for Canada as a whole, ignoring exports and imports. The solution of such a model is briefly described in the Technical Appendix to this chapter. In a second subsection the division of materials flows in Canada into flows within Ontario, between Ontario and the rest of Canada, within the rest of Canada, and between Canada and the rest of the world is described. In a third subsection, effects on employment of changes in industry output are described. Feedback effects through changes in aggregate demand are described in a final subsection.

(a) Material flow relationships in a closed, one-region economy

In this model, the classical input-output model advanced by Leontief, the orientation is strictly on the interrelationships among the level of output of different industries. The model focusses on two aspects of these interrelationships: the input requirements of production, and the composition of demand for outputs. Assuming that the relationships between input requirements and output are linear and independent of the level of output, the input requirements of each industry may be written as proportional to the industry's output. To be more specific, let Q_j be the output of industry j, and let a_{ij} be the amount of materials produced by industry i which are required to produce one unit of the output of industry j.

If the output of industry j is Q_j, this thus implies that the materials requirements of industry j consist of the vector

$$a_{ij} Q_j, \; i = 1, \ldots, N,$$

where N is the number of industries into which production figures are disaggregated.

The material requirements of one industry constitute a source of demand for the products of another. The total demand for the output of each industry is thus the sum of direct demands by consumers and from other sources of final demand (government, business investment in capital goods, exports, etc.) plus the sum of the amount of the industry output required for the production of other industries. Letting F_i denote the sum of all elements of final demand for the output of industry i, the total demand for the output of industry i can thus be written as

$$F_i + \sum_{j=1}^{N} a_{ij} Q_j$$

where the second term is the sum of all demands for the output of industry i resulting from the materials requirements of each industry. With the additional assumption that output equals total demand in each industry, the output of each industry is thus determined by the following N equations

$$Q_i = F_i + \Sigma_{j=1}^{N} a_{ij} Q_j, \quad i = 1, \ldots, N$$

This thus results in a model consisting of N linear equations in the output levels of each of the N industries; it thus can be solved for given values of the final demands F_i, given also the parameters a_{ij}.

The solution of this N-equation model is described in the Technical Appendix to this chapter. This appendix describes how the sequence of adjustments may be described in more formal terms.

A key thing to note with respect to all input-output models is the nature of the equilibrium represented by the solution to the input-output model. Several aspects of such models represent implicit specifications of the time horizon for which model forecasts are relevant.

In the case of the simple material-flow model, the model assumes that output changes are equal to changes in demand in industry output, and that purchases of materials are equal to their use. It thus assumes that sufficient time has elapsed for producers' expectations to have adapted to changes in demand, so that there are no changes in inventories which may have to be reversed in subsequent periods. The model is thus not a short-term model oriented to tracking quarterly fluctuations in industrial output.

On the other hand, the model assumes that the way in which materials and factor inputs may be considered is unchangeable - or at least will not change in a significant way from the way in which inputs are currently considered by producers. In thus assuming an unchanged technology and a limited opportunity to adapt producers' capital to allow different ways of consuming inputs, the predictions of the input-output model are likely to become increasingly incorrect as time passes after the introduction of a policy change. As a result, while not a model of output determination in the short run, the model is not a long run model either.

In effect, the model is subject to two types of error: (1) errors arising from the omission of inventory fluctuations and other causes of short-run variations in relationships among materials flows, and (2) errors arising from specifying a fixed production technology. Errors of the first type decrease in importance as the prediction horizon is lengthened, while errors of the second type increase in importance. The effect of the two types of errors is shown in Figure 2. As this figure indicates, there is a middle range (a period of say 2-5 years after a policy change) during which input-output forecasts are most likely to be accurate. Even in this

FIGURE 2: PREDICTION ERRORS FOR SIMPLE INPUT-OUTPUT MATERIALS FLOW MODEL

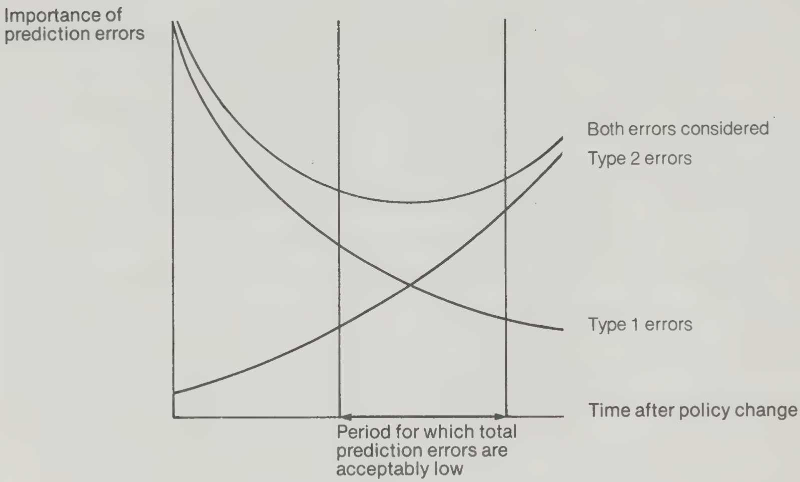
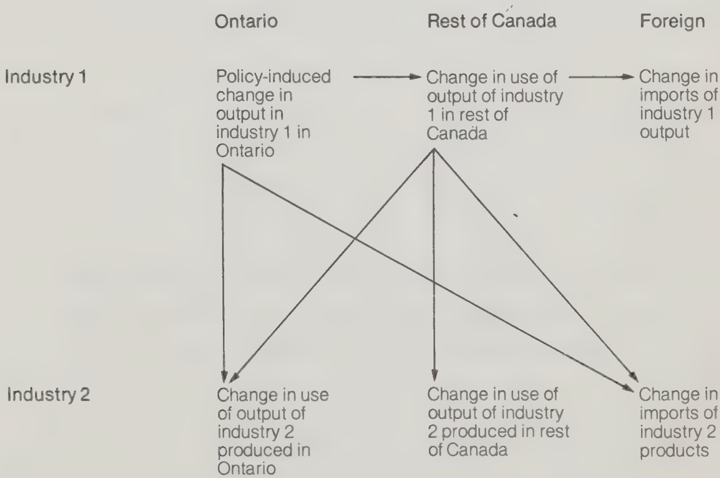


FIGURE 3: MATERIAL FLOWS IN A 2-REGION OPEN ECONOMY: SOME INITIAL ADJUSTMENTS TO POLICY-INDUCED CHANGE



middle range, they are of course still subject to the two sources of error.

The value and limitations of the input-output model can thus be placed in perspective with reference to the time horizon in which predictions are useful. As an example, consider the response of production in the Canadian economy to a significant change in the relative cost of energy (relative both to the cost of labour and capital and relative to other materials). In the very short run, because the technology embodied in existing capital equipment and production organization reflect decisions made in the context of a low relative cost of energy, the main effects of the change in energy prices will be through its effects on real incomes and hence on aggregate demand. Over a somewhat longer horizon, the composition of final demands will also be affected, as consumers and producers attempt to change their stock of consumers' and producers' durables to obtain more efficient forms of consumption and production. In the longer run, the way in which inputs are combined in production will change as producers' capital becomes increasingly adapted to permit the use of energy-conserving technology. The predictions of fixed-inefficient input-output models can in this context be viewed as predictions of what will occur in the short run once producers' expectations and inventories have adjusted to the shock of the change in relative energy costs.

(b) More complex material-flow models

The models described in this volume are all based on a more complex material flows model in which the origins of such flows are disaggregated into three components: production in Ontario, production in the rest of Canada, and production outside Canada. The greater complexity of the interrelationships is illustrated by Figure 3.

The interrelationships indicated in Figure 3 focus on the number of regions in which effects are to be analyzed. As the arrows in Figure 3 indicate, a policy-induced change in the demand for output of an industry ("industry 1") in Ontario will affect the demand for output of that industry in other parts of Canada. Other industries in Ontario ("industry 2") will have the demand for their output changed both in response to the change in the production level of industry 1 in Ontario and also in response to production changes in industry 1 in the rest of Canada.

Because of the feedback effects of changes which occur in production in the rest of Canada on production of Ontario industries, it is necessary to deal explicitly with industry output both in Ontario and in the rest of Canada in order to predict changes in Ontario production levels. This means that if there are N industries it is necessary to expand the simple model to include 2N sectors - N industries in Ontario plus N industries in the rest of Canada. Thus the demand equations written for the simple model need to be expanded as follows to describe output in both regions:

$$\Delta Q_i^{ONT} = \Delta F_i^{ONT} + \Delta G_i^{ONT} + \Sigma_{j=1}^{N} a_{ij} \Delta Q_j^{ONT}$$

$$+ \Sigma_{j=1}^{N} b_{ij} \Delta Q_i^{RC}$$

$$\Delta Q_i^{RC} = \Delta F_i^{RC} + \Delta G_i^{RC} + \Sigma_{j=1}^{N} c_{ij} \Delta Q_j^{ONT}$$

$$\Sigma_{j=1}^{N} d_{ij} \Delta Q_j^{RC}$$

where ΔQ_i^{ONT} = change in output of industry i producers located in Ontario

ΔQ_i^{RC} = change in output of industry i producers located in the rest of Canada

ΔF_i^{ONT} = change in aggregate final demands from Ontario sources for the products of industry i produced in Ontario

ΔF_i^{RC} = same for products produced in rest of Canada

ΔG_i^{ONT} = change in aggregate final demands from the rest of Canada for the output of Ontario producers in industry i.

ΔG_i^{RC} = same for products produced in rest of Canada

It may be noted that there are four times as many input-output coefficients to be estimated as in the simple model.

The reasons for differences among the input-output coefficients a_{ij}, b_{ij}, c_{ij}, and d_{ij} are worth elaborating. Why do we not find that $a_{ij} = c_{ij}$ and that $b_{ij} = d_{ij} = 0$, as we would if all industries were homogeneous and production were not subject to economies of scale? The answer to this question reflects the fact that industries are in fact not homogeneous, and that firms locate in different areas to reflect regional resources and to minimize transportation costs while taking advantage of economies of scale. Accordingly, the products produced by firms in an industry in one region are not in general the same as the products produced by firms in the same industry in another region. As a result of this specialization, the materials flows reflected in the a_{ij} matrix differ from those represented by the c_{ij} matrix, and the materials flows include interregional trade.

It should be noted, however, that there is more opportunity for substitutability among products of the same industry produced in different regions than among products produced by different industries. As a result, the multi-region input-output model is more sensitive to specification error arising from the assumption of fixed proportions applied to interregional material flows.

(c) Effects on employment

In the models used in this monograph, it is assumed that labour requirements in each industry are proportionate to output, and that labour employed is equal to labour requirements. Wages are assumed to be determined exogenously to the model, reflecting implicit or explicit assumptions that there is an excess supply of labour which has no feedback effect on the supply price of labour. Under these circumstances, the calculation of the employment effects of production changes predicted by the input-output model is trivial and straightforward and the labour requirements per unit of output in each industry have been estimated.

It must be emphasized that the grounds for assuming the demand for labour to be wage-inelastic and proportional to output are very weak, and that it is consequently necessary to take employment predictions made with a linear employment input-output model with a considerable grain of salt. In effect, what is being assumed is either that wages do not change relative to other costs or that there is no substitutability in production between labour and other inputs. Both assumptions are clearly false, both in the short run and in the long run. For a recent survey of evidence on the degree of substitutability between labour and capital in production, see Jorgenson (1972)[2]. The weight of current empirical evidence indicates that the long-run elasticity of substitution between capital and labour in most industries is closer to unity than to zero.

The assumption of a linear relationship between employment and output is least tenable in the short run. With capital fixed, the productivity of labour is likely to vary as capital/labour ratios are changed to produce different levels of output. Moreover, cyclical variations in productivity due to variations in hours worked per employee and to employer hoarding of skilled,

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[2]References are to items in the bibliography at the end of this monograph.

trained labour further cause the relationship among employment, wage income, and output to vary. For these reasons, the employment predictions of the linear input-output models described in this monograph should not be regarded as short-run predictions. (It should be noted that it is possible to combine an input-output material flows model with non-linear models of the production of value added by each industry; such indeed is the structure of the Economic Council of Canada's CANDIDE model. In such models the relationship between value-added and output is assumed to be linear, with a non-linear relationship allowed between employment and value added).

In a sense, what the predictions of a linear employment-output model assume is an extrapolation of the average technology embodied in the existing capital stock of an industry. They consequently should be viewed as indicative of how employment and output might change (over a horizon of 2 to 5 years) in response to a given policy variation if relative factor prices were unaffected and stayed unchanged. The thus-predicted changes in employment patterns may then be used as the basis for an examination of how the demand for factors (and hence relative factor prices) may be changed by the policy variation. In this context, input-output models should be viewed as the first step in a sequence of analyses which are required to make reliable predictions of policy effects on the demand for labor. They should not be viewed as directly providing predictions of the employment effects of policy changes.

A second step in such a sequence of analysis is obviously to relax the assumption of a perfectly elastic supply of labour at current wages in each labour market. Such relaxation requires the development of a disaggregated model of the movement of labour among industries in response to differential changes in the demand for labour in different industries. It further requires the incorporation of a model explaining the equilibration of the overall labour market to conditions of excess aggregate demand for labour or excess aggregate labour supply.

(d) Feedback effects on aggregate demand.

The effects on aggregate demand of changes in employment and earnings resulting from changes in production can potentially be modelled in a number of ways, reflecting different assumptions regarding the nature of the feedback effects of changes in aggregate demand. Generally, these different assumptions reflect different assumptions that may be made regarding the equilibration of the labour market and the consequent effects of changes in aggregate demand on wages and prices.

The assumptions made in the analyses reported in this monograph reflect the assumption of a perfect elastic supply of labour noted in discussing effects on employment. It thus corresponds to the short-run fixed-price Keynesian aggregate demand model in which production is assumed equal to aggregate demand. The effect of aggregate demand on the demand for output of each industry is assumed to be proportionate to the change in aggregate demand, reflecting an assumed unchanged product composition of consumption expenditures.

Solving the model under this assumption is only slightly more complicated than in the simple materials flow model; solution algorithms are briefly described in the Technical Appendix to this chapter.

The assumption of an unchanged product composition of consumption expenditures is equivalent to assuming that the income elasticity of demand for all products is the same. This assumption is not easily defended, in that it is likely that the demand for some types of goods will be relatively inelastic to changes in incomes, while the demand for other goods is relatively elastic. Most "necessities" will be characterized by relatively inelastic demand, while the demand for consumer durables and many consumption services will be relatively elastic. As a result, the assumption of an unchanged product composition of aggregate demand will cause the change in demand for necessities to be overstated by model predictions and cause the change in demand for durables, luxury goods, and services to be understated.

Beyond this, the assumption of an unchanged product composition of demand implicitly assumes either fixed relative prices for products or a uniform unit price elasticity of demand for all consumption goods. This implicit assumption is likewise not easily defended.

The quality of predictions made by the models used in the analyses in this monograph with respect to the incorporation of feedback effects resulting from changes in aggregate demand is thus on a par with that of the corresponding predictions of changes in employment and wages. Because of the assumption of no substitution in demand or production, the models' predictions are limited to showing what the effects of a policy change would be prior to subsequent adjustments of prices of products and factor inputs and prior to further adjustments to such price changes. Nevertheless, the model predictions are useful in indicating the magnitude and direction of such initial adjustments.

3. Extensions of input-output data

An important contribution made by the papers in this book is to extend existing input-output data in order to provide estimates of the detailed material flow relationships required to use the more complex interregional material flow models described above. These extensions are a required prerequisite not only for the policy analyses reported in this volume but also for other applications of input-output models.

In Chapter 2, the basic input-output data assembled by the Econometric Research Division of the Ontario Ministry of Treasury, Economics and Intergovernmental Affairs is described. This data is available in revised form in Data Appendix A. As is briefly noted in Chapter 2, there are a number of problems associated with the data, arising from assumptions made in constructing the data. However, the data provide (at least at a first-approximation level of quality) information on material flows that can be used to construct disaggregated models.

In Chapter 3, an important extension of the input-output data base for Ontario is presented. This extension consists of estimates of inter-regional trade flows between Ontario and the rest of Canada. This extension provides two forms of information not otherwise available: (1) It disaggregates the external-to-Ontario sector into two components, consisting of "rest of Canada" and foreign. (2) It provides detailed estimates of the flows between industries in the rest of Canada and industries in Ontario, so that exports and imports of each product (or product group) from Ontario to the rest of Canada are disaggregated by industry source. This is not done with respect to corresponding flows between Canada and the United States or between Canada and the rest of the world. Implicitly, it is assumed that flows outside Canada can be aggregated into total imports and exports of products but that intra-Canadian flows of products need to be disaggregated by industry source. In effect, this concentrates on intra-Canadian inter-industry feedbacks, and assumes that continental inter-industry feedback effects are less important because of the relative smallness of exports to Canada in the context of continental production.

The disaggregation of Ontario exports into exports outside Canada and exports to the rest of Canada is of significant importance. The analysis of economic flows in a region such as Ontario must occur within the context of the economy in which the region is embedded. Because of the obvious significance of the interaction between production in Ontario and demand in the rest of Canada, an analysis of

Ontario production flows cannot realistically be modelled without disaggregating Ontario exports (and imports) into intra-Canadian and international flows.

The procedures followed in constructing estimates of interregional materials flows are described in Chapter 3, which also provides an evaluation of the sensitivity of the results to the assumptions made in the process of constructing the estimates. Use of these estimates in an input-output model is of course also subject to the qualifications and conceptual difficulties noted in the previous section.

In Chapter 4, the Ontario government components of the vector of final demands for each industry is disaggregated . This is an important step towards understanding the detailed consequences of government policy changes. In particular, it is of signal usefulness in understanding the consequences of changes in the composition of government budgets (resulting e.g. from demographic factors or other factors that influence the relative political demand to different programs). As noted in this chapter, this disaggregation is not straightforward, and can consequently be questioned in numerous details. Nevertheless, it provides at least, a good first approximation to the direct impact at an industry level of changes in budget composition.

The empirical contributions presented in Part 1 of this monograph share this characteristic of being useful first approximations even though necessarily based on assumptions of debatable accuracy. While individual analysts might choose to make somewhat different assumptions in some cases, the limitations on these estimates are primarily caused by limitations in available data. Further improvements in these estimates will consequently require improvements in the underlying data.

4. Applications to fiscal policy analysis

Input-output models are applied to two types of policy issues in Part II of this monograph. In Chapter 7, Professors Boadway and Treddenick analyze the effects on employment in Ontario and in the rest of Canada resulting from changes in federal and Ontario provincial taxes. In Chapter 8, Professor Kubursi analyzes the effects on the regional distribution of income and employment of changes in the composition of Ontario government expenditures.

The policy analyses reported in Part II use more detailed specifications of the models described in the preceding section. In addition, the "standard" input-output model is extended in two important ways.

The nature of the applications of input-output models to fiscal policy problems is described in general terms in Chapter 6. As is noted in this chapter, the nature of the assumptions implicit in the use of input-output models conforms to the types of assumptions implicit in many neo-Keynesian macroeconomic models, in that they are essentially fixed-price, non-substitution models that extrapolate how equilibrium flows would change if market equilibrating forces were inhibited from operating. As such, they may be used to indicate the likely nature of market-equilibrating changes and in this sense can serve as the first step of a multi-step analytic process.

A number of qualifications necessarily associated with the use of input-output models to calculate employment multipliers are noted in Chapter 6. These have been previously described in Section 2 above.

The analysis reported in Chapter 6 is based on the use of the revised Ontario input-output table described in Chapter 2, without utilizing the additional information on interregional relationships provided in Chapter 3 and Data Appendix B. Such utilization would be straightforward in any subsequent application of the work to construct employment multipliers for government programs, and should be undertaken in further work in this area. Assuming the interregional flows to be exogenous and hence ignoring feedback effects into Ontario resulting from the impact of changes in Ontario production levels on demand in the rest of Canada is clearly a strong assumption.

This assumption is relaxed in Chapter 7, in which the more complete regional input-output model set out in Chapter 3 is used to calculate output and employment multipliers both for government expenditures (in total) and for important taxes. The principal focus of Chapter 7 is on the effect of changes in the mix of taxes used to finance government expenditures.

To predict the effects of tax changes on output and employment, it is necessary to specify a model of the effect of tax changes on product and factor prices and in addition to specify a model of the effect of the tax and price changes on output in each industry. In the Boadway-Treddenick analysis of the effect of tax changes, the first specification is made simply by postulating different degrees of forward shifting to product prices of tax changes. The second specification is made by assuming that industry output is affected only by changes in aggregate household consumption of industry output; no induced changes in investment, government expenditures, or exports are permitted. The induced changes in consumption are assumed to occur both in Ontario and in the rest of Canada. The induced changes in consumption are predicted using a simple model which does not allow for differing income and price elasticities of demand. It is assumed that consumption of all commodities is reduced in the same proportion in response to a change in disposable income, and that the price elasticity of real consumption of each single good is unity.

The assumptions about the degree of forward shifting are arbitrary, and serve primarily to indicate the sensitivity of the results to different assumptions. This sensitivity analysis is performed by calculating employment and output multipliers for tax changes under assumptions of zero or 100% forward shifting of each tax; these bracket the range of plausible extents to which forward shifting may occur.

The assumption of unit-elastic consumption demands for products is a strong assumption that ignores differences in the price and income elasticities of demand for different products. Beyond this, a more fundamental assumption made in this chapter is that returns to factors are exogenously determined except to the extent that tax changes in a specific industry are shifted forward. This assumption in effect ignores the important general equilibrium problem of the effect of taxes on real wages and on general market rates of return to capital. To the extent that general market rates of return are changed, an industry-specific tax change will affect rates of return in other industries, held constant by assumption in Chapter 7.

The above discussion is illustrative of the fact noted earlier in Section 2: namely, that input-output models do not serve very well as predictors of the long-run equilibrium changes that presumably are of importance in assessing the impact of tax changes.

A fundamental question that must be posed in analyzing the implications of empirical estimates prepared using input-output models is to determine the purpose of such analysis. Is it to predict the redistributive and longer-term economic effects of a change in the mix of taxes, keeping tax revenues or aggregate demand constant? Or is it to determine the extent to which aggregate demand needs to be altered in order to compensate for the effects on aggregate demand of a particular change in taxes (presumably implemented for some purpose other than aggregate demand management)?

Because of the numerous deficiencies of input-output models as representations of equilibrating processes that are important in determining incomes in the longer run, input-output models cannot provide very useful answers to the first question posed above. As noted previously, their usefulness as predictors is restricted outside a 2-year to 5-year forecast horizon. However, for aggregate demand management purposes, they can be used to provide useful information that is relevant to the second question.

It is therefore particularly useful to evaluate the empirical results presented in Chapter 7 in the context of this second question. How reliable are the employment multipliers calculated in Chapter 7 as measures of the need for compensating changes in macroeconomic policy to offset the aggregate demand effects of tax changes?

Because of the nature of the impact of tax changes, the most critical aspect of the model is the extent to which it correctly reflects the direct effects of tax changes or consumption. Unfortunately, the sensitivity of the empirical results to different specifications of the consumption demands component of the model is not tested, and it is possible consequently to note only that it is likely that the results may be highly sensitive to choices among alternative specifications.

Beyond this, the analyses reported in Chapter 7 are subject to the qualifications noted in Section 2 above. In particular, estimates of employment multipliers may be highly sensitive to the fact that labour markets are not explicitly modelled, and are assumed to determine wages exogenously without being affected by changes in industry output. In effect, the model assumes that changes in aggregate industry demands for labour do not affect wage rates (though obviously they affect total wage payments). This assumption is clearly invalid, and contradicted by fairly extensive empirical work that indicates an important effect of the extent of excess labour supply (i.e. of industry-specific unemployment) on contract-weighted wage settlements.

Taking all this into account, it is necessary to regard the empirical estimates presented in Chapter 7 not as predictions but as indicators. Given the potential sensitivity of the empirical estimates to assumptions which are almost certainly invalid, the estimates cannot be used by themselves to predict the effects of tax changes. At the same time, however, these assumptions make it possible to simplify the representation of complex inter-industry relationships so as to permit easy solution of the model representing these relationships. This computational simplification permits use of the model as a diagnostic tool, solving it for different representations of the consumption effects to see how sensitive the results are to different assumptions. As such, the models presented in Chapter 7 constitute a useful research tool, albeit one that should not be applied to policy analysis without considerable care.

A different orientation characterizes the analysis reported in Chapter 8. In this chapter, Professor Kubursi focusses on further disaggregation of the Ontario region into ten sub-regions and uses the input-output model for Ontario to obtain industry production totals for Ontario, with these being allocated to regions using data on the regional distribution of industry output. The input-output model is essentially the same as that used in Chapter 7, with the important exception that (as in Chapter 6) inter-regional trade flows between Ontario and the rest of Canada are not explicitly modelled.

To predict regional effects within Ontario of changes in provincial government expenditures, it is necessary to specify a model of the distribution across regions of the output and employment changes resulting from the expenditure changes. This is done in the analysis in Chapter 7 by assuming that the regional distribution of employment and output of each industry and government program is unchanged.

One problem which is of particular concern at the sub-regional level analyzed by Kubursi is the fact that industry aggregates are more meaningful at higher levels of spatial aggregation than at lower levels. The transportation industry in Northern Ontario (rail cars) is not the same as the transportation industry in Central Ontario (Automobiles and trucks), a problem that is avoided when dealing with industry averages over sufficiently large regions. The analysis of sub-regional effects is thus harder than the analysis of effects for all of Ontario.

Beyond this, the decomposition of Ontario into ten sub-regions results in a model which is more sensitive to mis-specification of labour market responses. Because of the relative smallness of sub-regions, it is more important to take account of labour migration. Analysis at the sub-region level must thus be regarded as more open to question, and hence applicable only with great care.

5. Empirical results

Some empirical results are presented in Chapters 7 and 8 in the form of estimates of the impact of fiscal policy changes on employment. These will be briefly reviewed in the light of the general comments made in previous sections.

The estimates of the effects of changes in different taxes presented in Chapter 7 need to be compared to the relative magnitude of those taxes in 1966 (the year for which the analysis reported in Chapter 7 is carried out). This is done in Table 1, which provides a rough basis for comparison for the percentage changes in aggregate employment resulting from a 20% change on different taxes. The range of estimates shown in the last column of Table 1 reflects different shifting assumptions for direct taxes. For indirect taxes, the estimates are for differing types of taxes (0.1% for federal tobacco taxes, 2.9% for the federal manufacturers' sales tax, 0.3% for the effects in Ontario of a change in the Ontario gasoline tax).

To interpret the numbers shown in Table 1, it is necessary to note that a unit-elastic response of employment to a federal tax change would imply that the figure shown in the last column of the table should be approximately one-fifth of the corresponding figure in the second column in the table.

Table 1 Comparison of the Relative Magnitude of 1966 Taxes (Relative to GNP) with Percentage Change in Employment Induced by 20% Change in Taxes

	Tax Revenues ($million)	Taxes as Percentage of GNP	Percentage change in employment resulting from 20% tax change
Personal income taxes			
- federal	3,634	5.9	1.0 - 1.4
- provincial	1,444	2.3	0.2
Direct taxes on corporations			
- federal	1,774	2.9	0.1 - 0.4
- provincial	581	0.9	0.0 - 0.1
Indirect taxes			
- federal	3,570	5.8	0.1 - 2.8
- provincial	2,622	4.2	0.1 - 0.3

Source: Statistics Canada, National Income and Expenditure Accounts (Cat. 130531), Vol. 1, Annual Estimates, 1926-1974, last column from tables in Chapter 7, below.

Thus, for the federal personal income tax, a unitary elasticity would imply a 1.2% change in employment as a result of a 20% change in federal personal income taxes.

The relative magnitude of provincial taxes shown in Table 1 is compared to the estimates in the last column of the effect on employment in Ontario of the change in corresponding Ontario taxes. This latter estimate is not strictly comparable with the provincial totals, since the estimates in the last column exclude the effects on Ontario production of corresponding tax changes enacted in other provinces. However, the low magnitude of the spillover effects of Ontario taxes on the rest of Canada (shown in Chapter 7 below) indicates that the comparison is nevertheless informative. From this viewpoint, the much lower figure in the last column of Table 1 for the effect of the Ontario personal income tax (which accounted for 24% of total provincial personal income tax revenues in 1966) is indicative of the importance of spillover effects to Ontario of tax changes implemented elsewhere. The effective spillover from the rest of Canada to Ontario is substantially larger than the reverse spillover from Ontario to the rest of Canada.

Some of the differences shown in Table 1 are not explained by the authors and need further study. The ratio of the impact of the Federal manufacturing sales tax to that of the Ontario retail sales tax is substantially greater than the corresponding ratio for personal income taxes, which is difficult to rationalize. In addition, the very small magnitude of the effect of a change in the federal corporation income tax is difficult to explain merely in terms of the effect of the exclusion of the effect of taxes on retained earnings. (The only channel through which unshifted corporate taxes affect employment in the Boadway-Treddenick model is through the effect on aggregate consumption of the change in dividends induced by the tax change.)

In using estimates derived from regional input-output models to analyze the employment effects of alternative tax changes, it is of signal importance to evaluate whether the resultant estimates are consistent with independent estimates of these employment effects. While such evaluation has not been done in this volume, it would be worthwhile for subsequent users of the estimates presented in this volume or of the underlying model to do so.

Nevertheless, in spite of these caveats and recognizing that they are only first approximations, the empirical results presented in Chapter 7 are of considerable interest as evidence for the relative ineffectiveness of fiscal policy at a provincial level. The substantially lower employment response to provincial tax changes (even after allowing for differences in the relative magnitude of federal and provincial taxes) is a strong argument for focussing provincial interest in stabilization on influencing initiatives taken at the federal level.

The empirical results presented in Chapter 8 are confined to an analysis of interregional differences in government expenditures per capita. Although of interest in their own right, conclusions should not be drawn from these results regarding interregional redistributive transfers without also analyzing interregional differences in tax payments per capita. Moreover, the analysis assumes that the interregional distribution of benefits from government spending is equivalent to the distribution of expenditures. This is a strong (and probably incorrect) assumption.

Given these problems, the estimates presented in Chapter 8 must be regarded as subject to substantial error. Even so, these estimates indicate that the indirect effects of government expenditures are relatively centralized in their location, and that the effect of government expenditures on employment is (because of these indirect effects) necessarily concentrated in the Central Ontario region.

The assumptions made in the policy applications are consistent with the spirit of the input-output models described earlier. In themselves, these assumptions are highly questionable. Nevertheless, this review of the empirical results indicates that they provide the basis for useful first approximations in predicting effects of policy changes. As such, they provide a tool for policy analysis that is of considerable usefulness provided that their limitations are kept in mind and that they are used as an initial analytic step rather than as a firm, final set of predictions.

Chapter 2

Input-Output Tables for Ontario

A. A. Kubursi

1. Introduction

The entire study is based principally on an adjusted version of the Ontario Input-Output Tables that were published in the January/February, 1972 edition of the Ontario Economic Review. These tables portray in detail the intricate structural framework of Ontario's economy for a single period of time in terms of inter-industry flows of goods and service and their interaction with the final demand sector (consumption, investment, government expenditures, exports and imports). The revised tables are reproduced in Data Appendix A.

2. The Analytical Framework

The Ontario economy is divided into 49 sectors on the basis of input and/or output homogeneity. The detailed composition of these sectors are displayed in a special table attached to the Data Appendix. The sectors are arranged in the same order along the rows and columns of the table. Each row of the table indicates the total output of each sector and its distribution among various other sectors to meet intermediate and final demand. Each column indicates the inputs required by each sector to produce a given level of output.

The inter-industry model is based on two fundamental identities. The first is that the total output of an industry - the sum of each row - is equal to its total inputs - the sum of each column. The second identity is that the sum of primary inputs - wages and salaries and other value added - is equal to the sum of final demands.

The input-output matrix of Ontario belongs to the general class of static open-Leontief models. It represents a static equilibrium model in the sense that its variables balance out, without surplus or deficit and reflect the structure of the economy at a given point of time. Demand equals supply at the price and/or income of the static equilibrium position. Within the context of the Ontario model, it is assumed that the national price index of sector i during 1965 represents the equilibrium price for that year in that sector. There are several basic underlying assumptions upon which the Ontario input-output matrix is predicated. These include the following:

(a) Each productive sector is assumed to produce a single commodity, i.e., joint production is ruled out. Since in reality this assumption is frequently violated, production of each sector is divided into primary and secondary. The secondary products are transferred to the sector to which they are considered primary.

(b) The production relation that connects outputs to inputs is assumed to exhibit the characteristics of a production function that is homogenous of degree one. This implies that constant returns to scale (constant costs) prevail in the production process.

(c) Substitution elasticities among the production processes are assumed to be nil. The production function is said to be of the fixed proportions variety, i.e., each input is used in such a way that it represents an invariant ratio of output j.

The usefulness of this approach is basically twofold. Firstly, the inter-industry tables serve as a device for storing and coding valuable and complex information concerning the structure of production and interdependency of the various sectors of the economy on each other. It provides, in other words, a chance to look "under the hood" of the economy and to watch the internal mechanisms of the economy in a consistent and orderly way. Secondly, the accounting tables can be used to solve analytically for the total output requirements that are necessary to meet final demand targets. This possibility has been utilized in a number of interesting theoretical and policy oriented studies such as the comparative advantage theories of trade (Heckscher-Ohlin theorem), disarmaments, planning industrial complexes, regional economics, manpower planning and even environmental studies. Our use of the tables to designate the economic impact of government expenditures on the various programs is yet another example of the usefulness of this framework.

3. Difficulties with the Analytical Approach

The difficulties encountered here are twofold: the first pertain to the general approach of input-output and the second set pertain to the Ontario input-output.

The assumption of one sector one product violates what is observed and the division of products into primary and secondary is arbitrary and biases the results obtained from this type of approach in an indefinite manner. Moreover, the assumption of constant returns to scale seems to contradict an enormous body of results on different economies of scale in different sectors especially in growing economies such as that of Ontario. Furthermore, the assumption of no substitution among factors is yet another difficulty that biases the results. Changes in relative prices of factors or products are assumed to have no influence on the amount used or produced of inputs and outputs. This assumption is surely questionable.

There are also some particular assumptions that are peculiar to the Ontario table. They include:

(a) Imports to final sectors and to intermediate sectors are not differentiated;

(b) Value added other than wages is estimated on a residual basis;

(c) Allocation of municipal government expenditures are made on the basis of ratios secured from the Quebec Bureau of Statistics;

(d) Conversion of purchaser's to producer's prices are made on the basis of national ratios of margin costs to purchase values.

These assumptions and procedures represent additional sources of errors and biases that should be taken into consideration when analysing the final results of this report.

4. The Results

The 49 x 49 sectors input-output of Ontario, irrespective of the difficulties it suffers and the tenuous assumptions upon which it is predicated, represents a detailed framework of inter-sectoral dependencies. It allows us to solve simultaneously for the vector of gross outputs of the 49 industries mentioned. It is generally consistent in that the sum of value added equals the sum of final demand. Moreover, the Gross Provincial Product that emerges from such summation is not substantially different from an independent estimate.

The input-output coefficients representing the technology of the industrial system of Ontario are generally acceptable. The stability conditions (Hawkin-Simons conditions) are satisfied for all sectors.

5. Evaluation of the Results

The specific assumptions pertaining to the Ontario input-output system are difficult to accept. The imports should at least be distinguished as to being competitive or non-competitive. The use of Quebec data reflect Quebec structure of production and not Ontario's. Furthermore, the use of national margins with different concentration indices and locational patterns impute positive biases to these idices in Ontario.

The adjustments made by Econometric Research on the original version are commendable. Federal government expenditures are now a separate column and imports and exports are segregated. The input-output coefficients of agriculture are adjusted to conform better with recent data. There are, however, several refinements that are still needed particularly those concerning imports, the margins, municipal government expenditures and a detailed account on a survey basis of the components of other value added.

Chapter 3

Ontario Foreign Trade Data

R. W. Boadway and J. M. Treddenick

1. Introduction

The Ontario economy is highly interdependent with the economy of the rest of Canada and, to a lesser extent, with the rest of the world. For example, Ontario "imports" significant amounts of oil and gas, agricultural products, and primary products, and "exports" a large proportion of manufacturing and mining products produced in Ontario. This interdependency is bound to have implications for the effects of fiscal policy conducted by the Ontario government in two ways. First, because of the openness of the Ontario economy, part of the impact of fiscal policy measures is likely to "leak" out of Ontario and into the rest of Canada. Second, to the extent that Ontario is a significantly large part of the entire Canadian economy, the impact of Ontario fiscal policy on the rest of Canada may be sizeable and may, in turn, feed back into the Ontario economy via induced effects on exports to the rest of Canada.

In order to attempt to assess some of the impacts of Ontario fiscal policy measures, we shall construct an inter-regional input-output table between Ontario and the rest of Canada. The table will show the flows of outputs of each industry in each of the two regions into industries in each region and into final demand use in each region for 1966. In addition, it will show the flows of payments to wages and salaries, surplus, and other value added, as well as the flows of exports and imports from foreign sources out of and into each region. The year 1966 is chosen since it represents the latest year for which input-output data is available for Canada.

This table simply represents the flows that actually took place in that year. In order to use the table to predict what the flows might be if, say, fiscal policy measures were undertaken, it is necessary to make some further assumptions about the nature of technology in each industry and demand for final use. This chapter will be devoted entirely to a description of the construction of the 1966 flows. The use of the tables to estimate the impacts of fiscal policy measures will be given in Chapter 7.

2. The Analytical Approach

The inter-regional input-output table to be constructed is shown in schematic form in Figure 1. This table categorizes the use of outputs in each of the two regions according to whether they are used (a) as an input into an industry in the same region, (b) as an input into an industry in the other region, (c) as an item of final demand in the same region, (d) as an item of final demand in the other region, or (e) as an export to foreign countries. It also categorizes the inputs into each industry in each region according to whether they are from (a) outputs of industries in the same region, (b) outputs of industries in the other region, (c) primary inputs from the same region, (d) primary outputs from the other region, or (e) imports from foreign sources. We proceed by first explaining in detail what is included in each of these "boxes" in Figure 1, and then by explaining how the numbers within the boxes were derived.

Each of the Ontario and rest of Canada economies are disaggregated into 16 industries. The boxes X^{OO}, X^{OC}, X^{CO}, and X^{CC} represent the dollar values of inter-industry flows of intermediate inputs amongst the industries of the two regions. Thus, X^{OO} contains 16 rows and 16 columns and and gives the flows from each Ontario industry to each Ontario industry. Each entry in X^{OO} represents the flow of inputs from the Ontario industry of its row into the production process of the Ontario industry of its column.

FIGURE 1: SCHEMATIC INPUT-OUTPUT TABLE

	Inputs into Ontario Industries	Inputs into Rest of Canada Industries	Final Demand in Ontario	Final Demand in Rest of Canada	Exports
Outputs of Ontario Industries	X^{oo}	X^{oc}	Y^{oo}	Y^{oc}	E^{of}
Outputs of Rest of Canada Industries	X^{co}	X^{cc}	Y^{co}	Y^{cc}	E^{cf}
Primary Inputs	V^{o}	V^{c}			
Inputs from Foreign Sources	M^{fo}	M^{fc}			

Similarly, X^{oc} is a 16 row by 16 column matrix representing the flows from each Ontario industry into each industry of the rest of Canada. Thus, an entry in X^{oc} represents a flow from the Ontario industry of that row into the rest of Canada industry of that column. X^{co} is a 16 row by 16 column matrix showing the flows from each industry in the rest of Canada to each industry in Ontario. And, X^{cc} is a 16 row by 16 column matrix giving the flows from each industry to each industry in the rest of Canada.

Each industry in both regions use, as inputs, primary factors of production and imports in addition to goods produced by other industries. The dollar values of these inputs are recorded in the boxes labelled V^o, V^c, M^{fo}, M^{fc}. Box V^o consists of 3 rows and 16 columns. The three rows represent payments to labour (wages and salaries), payments to capital (surplus), and other value-added payments made by Ontario industries. Similarly, V^c consists of 3 rows and 16 columns representing payments to labour, capital, and other value-added in the industries of the rest of Canada. M^{fo} has one row and 16 columns showing the imports from foreign sources used in each Ontario industry as inputs in production. Finally, M^{fc} is a row with 16 columns showing the imports from foreign sources into the rest of Canada industries.

The outputs of each industry, in addition to being used as inputs in industries, are also used for final demand or for exports. These are given in the six boxes in the top right-hand corner. Box Y^{oo} shows the final demand used by Ontario residents for the products of Ontario industries. It consists of 16 rows and 3 columns where the columns represent the final demand categories Consumption, Investment, and Government Expenditure. An entry in Y^{oo} shows the outputs of the industry in Ontario of that row which are used for final demand in Ontario by the category of that column. Similarly, Y^{oc} has 16 rows and 3 columns showing the flows of output from each Ontario industry into each category of final demand in the rest of Canada. And, E^{of} is a single column with 16 elements showing the flows of output from each Ontario industry used as exports. The boxes Y^{co}, Y^{cc}, and E^{cf} are defined in analogous ways. They show the flows of output from each industry in the rest of Canada that are used as final demand in Ontario (Y^{co}), final demand in the rest of Canada (Y^{cf}) and exports (E^{cf}).

It is worth noting that if we summed up the elements in any one of the first 32 columns we would obtain the value of total inputs going into that industry from all sources. And, if we summed the elements in each of the first 32 rows we would obtain the total output produced by that industry. Each of the row totals would equal the corresponding column total (total value of inputs in each industry must equal total value of outputs). Furthermore, if we were to divide each item in a column by the corresponding column total, we would obtain an "input-output coefficient" showing the value of that input used in that industry per dollar of output. For each industry, the sum of the input-output coefficients of inputs (intermediate, primary, and imported) would be unity.

We have left out of the above input-output table the bottom right-hand corner - that is, the use of primary inputs and imports as final demand. For example, government expenditures on labour (civil servants) is left out of the tables. These were omitted both because we did not have the data to construct them, but also because we did not require them for our analysis of fiscal policy effects.

The inter-regional input-output table described above was constructed using data from three sources - the input-output tables for Canada (Dominion Bureau of Statistics, 1969), the input-output tables for Ontario (Frank, Batrik and Haronitis, 1970), and data on inter-regional flows obtained from Appleton (1973). Since the Ontario input-output tables were for the year 1965, while those for Canada were for 1966, we have simply augmented the flows in the Ontario tables by the real rate of growth in 1966 (6.90%) to make them comparable. This procedure affects the size of the flows but not the input-output coefficients. The following subsections explain in detail the ways in which the data were manipulated to fill the boxes of Figure 1. These manipulations are defined in algebraic terms in the Technical Appendix to this Chapter.

a. Import Coefficients

The published Ontario and Canadian tables show flows of intermediate inputs inclusive of imports from outside the respective jurisdictions. Furthermore, exports from Ontario do not distinguish between exports to the rest of Canada and those to foreign countries. In order to combine the two tables into an inter-regional table we need flow data which separates imports into each region from domestic production and separates imports according to whether they come from foreign sources or from the other region. Such data on flows among regions and with foreign countries from each region are not readily available and we have had to improvise with data on inter-regional flows obtained from Appleton (1973).

The basic assumption we made regarding inter-regional and international flows is the following: for each region, the proportion of the regional product that is obtained from the other region is the same regardless of the use to which it is put (e.g., whether it is used as an intermediate input in an industry or for final demand, etc.); similarly, the proportion of the use of a product that is obtained from foreign sources is the same regardless of the use to which it is put. Thus, for each industry in each region, there is an "import coefficient" showing the proportion of the use of that industry's product that is obtained from the other region (e.g., import coefficients for the use of Ontario industry outputs in the rest of Canada). Also, there is an import coefficient showing the proportion of the use which comes from foreign sources. For each industry in each region the sum of the two import coefficients plus the proportion of that region's use of the product provided by domestic production adds to unity. In our analysis, we shall assume that all these import coefficients are constant. The set of import coefficients that we require for constructing our tables are as follows: from foreign sources into all of Canada, from foreign sources into Ontario, from the rest of Canada into Ontario and from Ontario to the rest of Canada. We also need the proportion of Ontario inputs from Ontario sources, but these are easily obtained by the requirement that the sum of the coefficients from all sources into Ontario be unity. Each of these sets consists of 16 coefficients, one for each industry. The method of deriving each one is explained below. The coefficients obtained are shown in Table 3 in Data Appendix B.

(i) Import Coefficients from Foreign Sources into Canada.

The import coefficients for each industry in Canada as a whole are calculated by taking the total imports from foreign sources and dividing by total industry output (or input) as obtained from the Canadian input-output tables. This import coefficient gives for each industry the proportions of the use of that industry's product which has been obtained from foreign sources.

(ii) Import Coefficients from Foreign Sources into Ontario.

The Agricultural Economics Research Council publication, Appleton (1973), lists import coefficients into each of four regions in Canada (Atlantic, Quebec, Ontario, and West) from the other regions and from foreign sources on a 25 industry basis. These are aggregated to our 16 industries by taking weighted averages of the 25 industry classification import coefficients, the weights being the proportions of industry outputs of the 25 industry classification in the 16 industry classification. The import coefficients from foreign sources into Ontario come directly from this aggregation.

(iii) Import Coefficients from the Rest of Canada into Ontario.

The import coefficients for Quebec, Atlantic, and West into Ontario on a 16 industry basis may simply be added for each industry to give an import coefficient for the rest of Canada into Ontario. Note that the coefficient of Ontario use met by Ontario production for each industry is found by subtracting the sum of the coefficients found in (ii) and (iii) from unity.

(iv) Import Coefficients from Ontario into the Rest of Canada.

These coefficients are not so readily available since the Agricultural Economics Research Council data give import coefficients from Ontario into each of the other three regions separately and they are not comparable with one another. Since no data were available on the relative magnitudes of flows from Ontario to the other three regions, we have arbitrarily taken a simple average of the coefficients of flows to these regions to obtain the import coefficients from Ontario to the rest of Canada.

Armed with these import coefficients, we may combine the Ontario and Canadian input-output tables into an interregional table.

b. Inter-industry Flows

We need to remove from the published Ontario input-output tables imports from foreign sources and imports from the rest of Canada. From the published Canadian tables we need to remove imports from foreign sources and segregate flows into the rest of Canada according to whether they come from the rest of Canada or Ontario. Doing these things involves a series of straightforward manipulations using the above calculated import coefficients and the two input-output tables. First of all, both tables must be aggregated to the same 16 industry basis. The listing of these industries is shown in the Data Appendix. The following list summarizes the steps taken in constructing the table of inter-regional flows of products.

(i) Foreign source imports were removed from Ontario inter-industry flows to give flows from all of Canada into Ontario by industry. This was accomplished by multiplying the elements in each row of the Ontario input-output flows by one minus the import coefficients from foreign sources into Ontario industries for each row.

(ii) In a similar way imports from foreign sources were removed from Canadian inter-industry flows to give flows from Canadian industries into Canadian industries. The elements of each row of the Canadian inter-industry flows were multiplied by one minus the import coefficient from foreign sources into the Canadian industries for each row.

(iii) The inter-industry flows from all of Canada into the rest of Canada were obtained by subtracting each element of the table obtained in (i) above from the corresponding element in (ii), i.e.,(the Ontario table exclusive of imports into Ontario is subtracted from the Canadian table exclusive of imports into Canada).

(iv) The inter-industry flows from Ontario industries into the rest of Canada industries were obtained from the flows obtained in (iii). That is, in table of flows from all of Canada into the rest of Canada, the elements of each row were multiplied by the import coefficient from Ontario into the rest of Canada industries for the industry of that row. The resultant table is X^{OC} in Figure 1.

(v) The inter-industry flows from industries in the rest of Canada into industries in the rest of Canada were obtained by subtracting each element of X^{OC} from (iv) from each element in the table given by (iii) showing inputs from all of Canada into the rest of Canada. This gives X^{CC} in Figure 1.

(vi) Inter-industry flows from the rest of Canada into Ontario were obtained by applying the import coefficients from each industry in the rest of Canada into Ontario industries to the elements of each row in the published Ontario tables. This gives box X^{CO} in Figure 1.

(vii) Lastly, inter-industry flows from Ontario industries into Ontario industries were obtained by applying the coefficients of Ontario use met by Ontario production to each element of the rows in the published Ontario tables. This gives box X^{OO} in Figure 1.

c. Final Demands and Exports

Boxes Y^{OO}, Y^{OC}, Y^{CO}, Y^{CC}, E^{Of}, and E^{Cf} are obtained by analogous procedures to that of subsection b. The appropriate import coefficients are applied to final demands in the Ontario and Canadian tables. The sequence of calculations is as follows.

(i) The coefficients showing the proportion of Ontario use coming from Ontario are multiplied by each row of final demands in the published Ontario tables to give

Ontario final demands purchased from Ontario industries. This is box Y^{OO} in Figure 1 and includes consumption, investment, and government expenditures.

(ii) The import coefficients from the rest of Canada into Ontario are applied to each row of the final demands in the Ontario input-output tables to give Y^{CO}, the final demands by Ontario from industries in the rest of Canada.

(iii) Final demands by all of Canada from Canadian industries is obtained by multiplying each row of final demands in the Canadian input-output tables by one minus the import coefficient from foreign sources into Canada. Adding each element in (i) and (ii) (Y^{OO} + Y^{CO}) and subtracting from the corresponding element in the final demands by all of Canada from Canadian industries gives the final demands by all of Canada purchased from industries in the rest of Canada. Finally, multiplying each row of these final demands by the import coefficients from Ontario into the rest of Canada gives final demands by the rest of Canada purchased from Ontario industries. This is box Y^{OC} in Figure 1.

(iv) To obtain final demands by the rest of Canada from industries in the rest of Canada we subtract the elements of final demands by the rest of Canada from Ontario from the corresponding final demands by the rest of Canada from Canadian industries. The result is Y^{CC} in Figure 1.

(v) "Exports" from Ontario to the rest of Canada by industry are found by summing each row in Y^{OC} (consumption, investment, and government expenditures by the rest of Canada from Ontario industries). Total exports from Ontario to foreign countries are total exports from Ontario in the input-output tables less exports to the rest of Canada. This gives E^{Of}.

(vi) Finally, exports from the rest of Canada to foreign countries are total exports from Canada (as given in the input-output tables) less Ontario exports to foreign countries by industry. This yields E^{cf} in Figure 1.

d. Primary Inputs

Primary inputs are classified according to the following three categories - wages and salaries, surplus, and other value added. Surplus includes all returns to capital gross of both depreciation and corporate tax payments. Other value added includes indirect taxes (primarily property taxes, but excluding commodity taxes), non-competing imports, balance of payments adjustment, government services and subsidies. For a discussion of these items the reader is referred to Dominion Bureau of Statistics (1969). These vectors of primary inputs for all of Canada are readily available from the input-output tables (after aggregating the items in other value added). However, for Ontario, the published input-output tables aggregate surplus with other value added and show only two primary inputs - wages and salaries, and other value added. Since we could not obtain data directly on the magnitudes of surplus in the Ontario tables, we have assumed that the ratio of surplus to wages and salaries for each industry in Ontario is the same as that for Canada as a whole. This ratio, obtained from the Canadian tables, was used to disaggregate the Ontario primary inputs into the above three categories. These appear as V^{o} in Figure 1.

The primary inputs of the rest of Canada industries are obtained simply by subtracting the primary inputs for Ontario by industry from those for all of Canada. The result is V^{c} in Figure 1.

e. Imports for Intermediate Use

In addition to intermediate inputs from Canadian industries and primary inputs, domestic output in both Ontario and the rest of Canada is produced using some intermediate inputs imported from foreign sources. These are obtained as residuals from the above calculations as follows. Total outputs of Ontario industries are obtained by summing the elements of each of the first 16 rows in Figure 1. Similarly, the total outputs in the rest of Canada industries are the sums of the second 16 rows. Since total outputs of each industry must equal total inputs, row totals must equal column totals for the 16 industries in both Ontario and the rest of Canada. The flow of foreign imports into Ontario is found by subtracting from each total industry output (row total) the sum of intermediate inputs from Ontario and the rest of Canada and primary inputs. This gives M^{fo}. The same procedure is applied to the 16 industries in the rest of Canada to give imports into the rest of Canada industries from foreign sources (M^{fc}).

This completes the construction of input-output flows. For purposes of the analysis to follow the first 32 columns of the flow input-output tables can be converted to input-output coefficients by dividing each element by the corresponding column total.

3. Difficulties in Constructing the Table

The main difficulties encountered in constructing the above tables of flows and coefficients are not conceptual but empirical. The data available for segregating the various flows are crude and not entirely reliable. This is especially true of the data on imports into the two regions from the other region and the rest of the world. Detailed data on inter-provincial flows are not available nor are detailed data on the destination of imports from foreign sources to domestic industries. We are therefore forced to make the assumption that regardless of the use to which an industry's output is put, the proportion that comes from imports from various sources is the same. This assumption, strong as it may appear, is also used in the Canadian input-output tables to remove imports from inter-industry flows and final demands.

Even with this simplifying assumption, data are not readily available for calculating import coefficients. We do not know the flow of aggregate imports by industry into each region from each outside source. We have therefore had to rely on import coefficients computed by the Agricultural Economics Research Council which were computed for a different aggregation of industries and for a four-region input-output model.

Another minor data problem arises in disaggregating the primary inputs in the Ontario table into wages, surplus, and other valued added. Since the latter two are not dis-aggregated in the published tables, we have had to rely on the crude assumption that they bear the same proportions to one another in the Ontario table as in the Canadian table by industry.

Finally, we have had to work at a fairly high level of aggregation in constructing the inter-regional input-output tables, once again due to data limitation. In principle, the greater the disaggregation of industries, the more reliable would our later results be.

The flow table itself gives only a snapshot of the economy for a given year (1966). The problems in constructing that snapshot are really data limitations. Where the stronger restrictions are going to arise is later in Chapter 3 when the input-output tables are used to analyse changes in taxes and government expenditures. Further we are going to ask what the economy would look like if a change were to occur and it will be necessary to make assumptions about the nature of technology and final demands.

4. Results

The import coefficients calculated for each region, the inter-regional input-output flows table, and the input-output coefficients are all presented in tabular form in the Data Appendix. We restrict ourselves here to a brief overview of the data obtained.

The pattern of import coefficients into Ontario and the proportion of Ontario use met from Ontario production conforms to what we would expect _a priori_. Ontario relies on domestic production entirely for Construction, and almost entirely for Transportation, Storage and Trade, Utilities, and Communication and Services. These sectors constitute what might be termed the non-traded sectors. On the other extreme, Ontario relies almost entirely on the rest of Canada for Mineral Fuels (i.e., oil and gas from Alberta). Other than Textiles, which are almost 60% imported, Ontario provides over 60% of the supplies of the remaining industries (primary industries and manufacturing). The industry receiving the largest proportion from foreign sources is Transportation and Electrical Equipment, largely due to motor vehicles imported under the Auto Pact.

The pattern of imports into the rest of Canada from Ontario are also fairly predictable. Over 45% of Transport and Electrical Equipment comes from Ontario as does 25% of Metals and 24% of Textiles. None of the "non-traded" sector outputs come from Ontario nor does any of the Mineral Fuels.

The other category given shows imports from foreign sources into all of Canada. It indicates that 30% of Transport and Electrical Equipment is imported and 22% of both Metals and Other Manufacturing.

These patterns are, of course, reflected in the flows and coefficients themselves. The flows from the rest of Canada into Ontario and Ontario into the rest of Canada are quite light compared with the flows within the regions themselves except for the ones mentioned above. The flows tables also give us an indication of the relative magnitudes of different industries. In the rest of Canada, Transportation, Storage and Trade and Communications and Services are considerably larger than any other industry with Construction the next largest. Utilities and Mineral Fuels are the smallest. In Ontario, the pattern is similar except that Metals and Transport and Electrical Equipment are larger than Transportation, Trade and Storage. In addition, Mines and Wood and Furniture are fairly small. In addition, in final demands, notice that government expenditures tend to be concentrated in processed manufacturing sectors, non-traded sectors, and Agriculture, Forestry, Fishing and Trapping.

Finally, the input-output coefficients give us some useful information on the relative magnitudes of wage and salary payments and surplus payments. Both Construction and Transportation, and Storage and Trade rely relatively heavily on Wages and Salaries as inputs, with Wood and Furniture, Other Manufacturing, and Communications and Services being slightly less. We may consider these sectors to be relatively labour-intensive. On the other hand, the primary industries and Food, Feed and Beverages make proportionately low payments to Wages and Salaries and are much less labour-intensive.

5. Evaluation of Results

As unreliable as the data might seem to be in principle, they do conform broadly with what we might expect <u>a priori</u> about the relations between Ontario, the rest of Canada and foreign countries. Furthermore, it is consistent with the underlying Ontario and Canadian tables from which they were constructed. Obviously, in using them we cannot rely on the results for more than "order-of-magnitude" estimates of the effects of fiscal policy.

To the extent that it is useful to have an inter-regional input-output table at all, it would be desirable to have more reliable data on inter-provincial flows of products by industry not only by source of import but also by destination (to industry or final demand use). At a somewhat lower level of priority it would also be useful to disaggregate the rest of Canada into regions and work with a full-fledged multi-regional input-output table.

The application of this data to the study of the effects of Ontario fiscal policy measures will involve making stronger assumptions of a more analytical nature. In interpreting the results of that analysis, the reader should bear in mind the approximate nature of the data being used.

Chapter 4

Ontario Government Expenditures by Industry

A. A. Kubursi

1. Introduction

The input-output method treats consumption, investment and government expenditures as vectors rather than individual numbers. Thus the multipliers developed using this method ultimately reveal the overall effect of changes in consumption, investment and government expenditures on industries. But governments do not decide on their industrial purchases until they have decided on the programs they intend to pursue and the departments (ministries) responsible for implementing these programs. In this regard government expenditures are no longer a vector but a matrix. Corresponding to each program there is a detailed vector of purchases from industries, each one is unique and substantially different from the rest of the vectors.

2. The Analytical Approach

Government programs involve generating a product or a service whose production requires a combination of inputs. Our approach assumes that the government programs correspond to the production activities of the economy where inputs are used in fixed proportions to the output produced and are invariant to the level of production. Labour is considered to be the only primary input and a strict distinction between labour and other inputs is maintained throughout the construction of the government expenditure matrix.

The budget process in Ontario involves allocating spending authority to various departments (ministries). These departments often correspond in a strict manner to a unique program, however, there are several exceptions to this correspondence. The first expenditure matrix was constructed for departments -- twenty-three of them.

Following that, we generated a convertor matrix that maps departments into programs. The analytical details of the matrix are presented in Table 1. Different offices of the same department perform different functions. Thus, expenditures of these offices as detailed in Ontario Government Public Accounts were assigned SICs (Standard Industrial Classifications) and credited to the primary program they fall under. The expenditures are classified as salaries or as purchases from companies. Only expenditures exceeding $5,000 are reported. The various companies were allotted SIC numbers according to the main activity of the company or where known according to the service performed for the government.

3. Difficulties with the Approach

Several difficulties were encountered in constructing the government expenditure matrices. For one, the data available in the Public Accounts is rather vague. Contracts awarded to companies are not detailed, the nature of the service covered is not known. Besides the data cover fiscal years and not calendar years which happen to be the basis of the input-output tables. Furthermore, the assignment of the various offices in the different departments to particular functions suffers from several arbitrary judgments, especially when one office serves more than one function. We have resorted to the practice of assigning all its expenditures to each function it performs. Therefore, adding all the programs together will exceed the actual budget. Thus, our procedure applies only to individual programs treated separately.

The treatment of government programs as if they represent productive activities is itself questionable especially when the outputs of these programs are unrecognizeable or are difficult to measure. Furthermore, treating the purchases from industries ascribed to each program as if they are fixed proportions in just the same way industrial purchases of any other industry are treated is rather a strong assumption that requires further consideration.

4. The Results

The expenditure coefficients by level of government and by program are presented in Tabular form in the Data Appendix.

The results indicate a wide variation in the industrial composition of government expenditures. Local government in Ontario, for instance, spends 17¢ per one dollar of expenditure on industrial outputs, whereas the Federal government spends 33¢ and Ontario government spends 34¢, respectively.

Each program appears to possess a unique set of industrial purchases that are not duplicated by other programs. The Transportation and Communication program involves purchases from the expected type of industries, whereas expenditures on Health involve another set of industries.

The relative shares of wages and salaries of total program expenditures vary from program to program. The relative share of wages and salaries of Transportation and Communication is the lowest at 26¢ and highest for Public Protection and Safety at 78¢.

Finally, associated with most programs is a small set of industries that account for the largest component of industrial purchases. For instance, construction, maintenance and repairs accounts for 28¢ of one dollar expenditure on Transportation and Communication. The same industry accounts for 37¢ for General Government.

5. Evaluation of the Results

The importance of classifying government expenditure according to the decision-making unit and tracing it to industrial sectors cannot be overstated. The procedures followed here include a number of contestable propositions and the data itself cannot be classified as totally reliable. However, the results seem to conform generally to what might be expected of them on *a priori* grounds. For instance, most programs involve substantial payments to wages and salaries but these payments form different proportions of each dollar expenditure. This fact is clearly observed in our results. Furthermore, certain industries are more important than others in supplying the required inputs to government. This fact is equally revealed.

To the extent that it is desirable to express government expenditures as a matrix, it would be useful to assign these expenditures SIC numbers and the designation of the purpose of expenditure. There is at present a move to improve the classification of government expenditures by TEIGA through what is known as the Diamond Coded System. This system represents an unequivocal improvement over the old system, but it falls short of providing the type of information we are requesting.

TABLE I: DEPARTMENTS BY PROGRAM

Department / Program	General Government	Public Safety Protection	Social and Economic Welfare	Health	Education	Recreation and Culture	Home and Community Environment	Transportation and Communications	Industrial Development and Provincial Resources
Civil Service	a) Main Office b) Position Administration c) Recruiting and Examination Services d) Training and Development Services e) Administrative Services f) Pay Research g) Ontario Joint Council h) Employee Relations								
Department of the Attorney General	a) Legislative Counsel.	a) Public Safety Division b) Ontario Provincial Police c) Ontario Police Commission d) Administration and Finance e) Ontario Securities Branch f) Criminal Law Division g) Legislation and Civil Law Division h) Main Office i) Administration of Justice Division							

TABLE I: DEPARTMENTS BY PROGRAM

Department \ Program	General Government	Public Safety Protection	Social and Economic Welfare	Health	Education	Recreation and Culture	Home and Community Environment	Transportation and Communications	Industrial Development and Provincial Resources
Office of the Lieutenant Governor	a) Office of the Lieutenant Governor								
Mines Department		a) Mines Inspection Branch b) Laboratories Branch c) Sulphur Fumes Arbitrator							a) Main Office b) Geological Branch c) Mining Lands Branch
Prime Minister's Office	a) Main Office								
Provincial Auditor's Office	a) Administration of the Audit Act and Statutory Audits								
Provincial Secretary and Citizenship	a) Main Office b) Legislative Services c) Queen's Printer d) Post Office								
Public Works Department	a) Main Office b) Ontario Government Buildings								

TABLE I: DEPARTMENTS BY PROGRAM

Program / Department	General Government	Public Safety Protection	Social and Economic Welfare	Health	Education	Recreation and Culture	Home and Community Environment	Transportation and Communications	Industrial Development and Provincial Resources
Treasury	a) General Administration b) Accounts Division c) Revenue Division d) Province of Ontario Savings Office e) Data Processing Branch	a) Pension Commission of Ontario				a) Ontario Racing Commission			
Department of Economics and Development	a) Economic Council b) Economics Branch c) Main Office d) Ontario House e) Financial Research Branch						a) Ontario Development Agency b) Housing Branch		a) Trade and Industrial Branch b) Regional Development Services c) Special Research and Surveys Branch d) Ontario Research Foundation
Department of Labour		a) Safety and Technical Services b) Human Rights Commission c) Labour Standards	a) Labour Relations Board b) Conciliation Services Branch		a) Main Office b) Apprenticeship Branch				

TABLE I: DEPARTMENTS BY PROGRAM

Program / Department	General Government	Public Safety Protection	Social and Economic Welfare	Health	Education	Recreation and Culture	Home and Community Environment	Transportation and Communications	Industrial Development and Provincial Resources
Department of Transport		a) Main Office b) Highway Safety Branch c) Motor Vehicles Administration d) Motor Vehicles Claims Fund						a) Ontario Highway Transport Board	
Reform Institutions Department			a) Main Office b) Parole and Rehabilitation Services c) Institutions						
Public Welfare Department			a) Main Office b) General Welfare Assistance Branches						
Department of Health				a) Main Office b) Public Health c) Mental Health d) Hospital Services Commission of Ontario					

TABLE I: DEPARTMENTS BY PROGRAM

Program / Department	General Government	Public Safety Protection	Social and Economic Welfare	Health	Education	Recreation and Culture	Home and Community Environment	Transportation and Communications	Industrial Development and Provincial Resources
Department of Municipal Affairs							a) Main Office b) Ontario Municipal Board		
Department of Education					a) Main Office b) Formal Education c) Assistance to School Authori- d) Special Educational Services Branch e) Continuing Education f) Youth Service Division	a) Community Programmes Branch b) Ontario Fitness Programme c) Provincial Library Services			
Department of Tourism and Information						a) Main Office b) Division of Archives c) Theatres Branch d) Travel Research			a) Tourist Promotion & Information Branch b) Tourist Industry & Develop.Branch

TABLE I: DEPARTMENTS BY PROGRAM

Program / Department	General Government	Public Safety Protection	Social and Economic Welfare	Health	Education	Recreation and Culture	Home and Community Environment	Transportation and Communications	Industrial Development and Provincial Resources
Department of University Affairs						a) Main Office			
Department of Lands & Forests						a) Parks Branch b) Research Branch			a) Main Office b) Resource Protection and Develop.
Department of Highways								a) Main Office b) King's Highways & other Roads	
Department of Agriculture									a) Main Office b) Agricultural Production c) Rural Development d) Agricultural Marketing e) Agricultural Education and Research

TABLE I: DEPARTMENTS BY PROGRAM

Program / Department	General Government	Public Safety Protection	Social and Economic Welfare	Health	Education	Recreation and Culture	Home and Community Environment	Transportation and Communications	Industrial Development / Provincial Resources
Energy Resources Management				a) Water Management Program b) Ontario Water Resources Commission					a) Main Office b) Conservation Authorities Branch c) Energy Branch d) Ontario Energy Board

Chapter 5

Ontario Regional Wages and Value Added by Industry

A. A. Kubursi

1. Introduction

The model in this study is developed in an input-output framework. The general approach is to assume a unit increase in a government expenditure program (say Health). This unit is allocated to industrial purchases and direct primary input use. Then a conventional input-output calculation is performed to determine the effects on provincial output levels using the Ontario Input-Output Table. The amount of income generated in each region is determined from data on Mining and Manufacturing and on Non-Mining and Manufacturing total value added and wage value added. The dichotomization of Mining-Manufacturing and the rest of the sectors is necessary in view of the relatively high reliability of the data on Mining-Manufacturing compared with the poor quality of data for the other sectors, which necessitates a more cautious interpretation of Non-Mining and Manufacturing results.

2. The Analytical Approach

The total value added and wage value added by region and sector in Ontario for the base year 1965 were obtained from a number of unpublished sources. Information for the Manufacturing and Mining industries was provided by the Regional Statistical Branch, Statistics Canada. They pertain primarily to what is known as Census Value Added. The latter concept differs from national accounting value added in several respects. Most important of which is the fact that Census Value Added (CVA) includes items excluded in national accounting value added such as advertising and other related expenses. To the extent that these items are important, the CVA will deviate significantly from the national accounting counterpart which is adopted in the input-output system.

For industries outside the Manufacturing-Mining group, estimates were obtained from a large number of sources. The data are admittedly of poor quality and rest on several crucial assumptions.

In the case of Agriculture, it was necessary to assume that value added by region was proportional to the value of agricultural products sold. In the case of Forestry, it was assumed that the value of yield per acre of non-farm privately-owned land was the same as value of yield per acre of census-farm woodlots. Fishing value added was allocated according to the value of commercial harvest from the public waters of Ontario. Value added in Construction, Maintenance and Repair was allocated in a proportion to the value of residential and non-residential construction in 1965. Wherever possible, the author followed the judgement of experienced personnel in the industry concerned. Because of the considerable detail within broad industrial classifications, it was occasionally necessary to fall back on proxy variables such as population or personal income. When such proxy variables were employed, the outcome was rather insensitive to the variable chosen. Because the quality of the data for industries outside of Manufacturing is not as good as those in the Manufacturing group, results for these two groups have been obtained separately throughout the study.

References employed in calculating regional shares estimates for industries outside the Manufacturing group are listed below.

3. Difficulties with the Analytical Approach

The use of Census Value Added as a proxy for national accounting value added may be inappropriate in view of the fact that the former overstates the latter. This is particularly true for establishments located in central

SECTOR	INFORMATION SOURCES
INDUSTRY 1:	
AGRICULTURE, FORESTRY AND FISHING	D.B.S., 1966 Census of Agriculture (Ontario), 96-607, Table 23. Acreage figures from: Ontario Department of Lands and Forests, Report of the Forestry Study Unit, 1967, 70-71. Ontario Department of Lands and Forests, Statistical Reference, 1967, 196. Ontario Department of Lands and Forests, Fish and Wildlife Branch, Commercial Fish Harvest by Economic Region from the Public Waters of Ontario, 1964-1969: Quantities of Fish Landed (Pounds) and Total Value to the Fisherman (Dollars)
INDUSTRY 45:	
CONSTRUCTION, MAINTENANCE AND REPAIR	D.B.S., Building Permits, 1969, 64-203, Table 6.
INDUSTRY 46:	
TRANSPORTATION, STORAGE AND TRADE	Ontario Department of Treasury and Economics, Economic Analysis Branch, Provincial and Regional Accounts Section, Personal Income, 1965, by Economic Region.
INDUSTRY 47:	
UTILITIES	D.B.S., 1966 Census, 92-601, Volume I (1-1), Table 2.
INDUSTRY 48:	
COMMUNICATIONS AND OTHER SERVICES	D.B.S., 1966 Census, Retail Trade.

regions. Thus, the regional pattern of CVA is usually different from that of value added. Since our study is concerned with the regional pattern of income and it uses CVA, the pattern that emerges is undoubtedly different from that that would have emerged had value added figures been used.

The various assumptions used to allocate value added of the Non-Mining and Manufacturing industries are subject to several reservations. Resort to these was made in view of the total absence of any direct and exact method. In most of our calculation we were careful to segregate the income arising in Mining-Manufacturing and that arising in the other group of industries. The former is based on firmer grounds than the latter and is, therefore, more reliable.

4. The Results

The data generated reflect substantial variation in the regional pattern of industrial value added distribution. It is this variation that accounts for the ultimate nature of income disparities among regions in Ontario. The regional pattern that emerged appears consistent with the locational pattern of industries in Ontario. The Northern regions reflect an industrial base with resource orientation, Georgian Bay tourism and furniture and fixture, whereas central Ontario reflects a diversified industrial base with a noticeable concentration of heavy industries.

5. Evaluation of the Results

Given the admittedly poor data base used to regionalize value added in the Non-Mining and Manufacturing industries, the results should be analysed with extra care and caution. The use of CVA biases income distribution in favour of the central regions and this source of bias is not small depending on how large are head-office expenses and other expenses not attributed directly to establishments.

The fact that information on value added and wages by non-manufacturing sectors is scanty calls for additional attention from the statistical organizations of the province and in Ottawa to rectify this deficiency. Its availability facilitates the task of analyzing income disparities among regions and the expected incomes from industrial expansions.

Chapter 6

Differential Income and Employment Multipliers of Ontario Government Expenditures

A. A. Kubursi

1. Introduction

In the theory of fiscal policy, it is sometimes convenient to represent the government as choosing between taxes and expenditures as policy instruments for controlling the level of aggregate demand. In practice, of course, both approaches must be considered over simplifications: there is a wide variety of possible avenues for tax changes and there are numerous alternative ways in which the government can spend.

Recently there has been a dramatic shift in the attention given to the expenditure side of the budget by public finance scholars. Much of this attention has been directed to an examination of government expenditure decisions. PPBS has provided a framework for this examination and techniques such as cost-benefit and cost-effectiveness analysis have been developed to compare various government programs. Cost-benefit studies are usually conducted within a partial equilibrium framework, however, and do not trace the full economic impact of specific programs. In particular, they do not indicate the relative impact of the various programs on total income level and employment.

Macroeconomic studies, on the other hand, have been concerned with the impact of an aggregate variable of government expenditures on employment and level of income. Only recently, however, has attention been paid to the effects of changes in the composition of these expenditures (Peacock and Stewart, 1958; Roskamp, 1969), with government treated as an ultimate buyer whose purchases are traced to particular industries through an input-output model. However, these studies have tended to neglect the fact that variations in government expenditures entail changes in industrial purchases as a consequence of changes in government programs or functions (Strout, 1958; qualified as a unique exception). This neglect seems clearly undesirable, for government purchases from industries normally depend on the magnitude and nature of different programs. Consequently, the impact of changes in the industrial composition of government expenditures should be analyzed in terms of changes in the composition of those programs.

In the following application of input-output, it is our purpose to examine an important policy area which is neglected in both cost-benefit studies and macroeconomic studies, namely the aggregate impact of various government programs on the level of income and employment.

2. The Analytical Approach

Multiplier analysis is generally associated with Keynesian models of income determination. The income multiplier in Keynesian macroeconomics is the overall total of direct and indirect income effects of a dollar increase in final demand. This summing of direct and indirect income effect is quite similar to the summing of direct and indirect output effects in input-output analysis. In fact, as we demonstrate in the Mathematical Appendix, it is also possible to use the input-output method to evaluate the income effect due to a unit change in final demand. Furthermore, there is a certain advantage in using the input-output method. By the very nature of macroeconomics, its income-multiplier analysis is conducted at the most general level. It does not ask who will produce the extra output when final demand is increased, or in which sector of the economy will this extra output be used. The locational pattern is totally absent and the monitoring or decision-making units are often concealed. Governments and businesses would like to know precisely what kind of goods and services people want more if they are to draw proper production plans. These shortcomings of aggregate analysis can be overcome if input-output analysis is used instead. For input-output analysis focuses on individual sectors, not on the national totals.

For analytical and computational purposes, the model distinguishes between the income generated by direct and indirect output effects, and the additional income induced by the spending of increased income. The former type of income generation arises out of the production process, whereas the latter depends on propensities to consume and other leakages such as imports and taxes.

The distinction between direct and indirect income effects, and direct, indirect and induced income effects may be illustrated by considering the events which take place when demand increases for the output of a given industry. As the output of this industry expands, income accrues to households (value added) in the regions where the industry is located, giving rise to what is referred to here as the <u>direct income effects</u> of that industry. But the output of one industry cannot be expanded without drawing on the output of other industries and, when the output of these industries is expanded to fill new orders, income is again generated in one or more regions. These are called <u>indirect income effects</u>. The process is further complicated, moreover, by the fact that, as income expands as a consequence of the direct and indirect effects, households will increase their purchases of goods and services, thereby giving rise to still further production and income. These latter effects are referred to as the <u>induced income effects</u>.

The approach utilized here distinguishes two types of multipliers. The ordinary and often used concept, which has already been mentioned, and which includes total income effects (direct, indirect and induced) in the numerator and a dollar increase in final demand in the denominator. Another multiplier concept is also used. This includes the same elements in the numerator as the ordinary concept, but replaces the denominator. Instead the coefficient of the direct portion of expenditures allocated to wages is inserted. This component is called the initial income payment. This concept of multiplier is not new and has been used by (Moore, 1955). What this multiplier represents is essentially the spread between total income effects and initial income effects and, therefore tends to reflect more clearly the interdependencies of the economy than the ordinary multiplier concept. However, it suffers from the fact that it does not conform to what is generally considered to be a multiplier (i.e., response of an endogenous variable to a unit change in an exogenous variable).

In addition to the general assumptions made about the input-output analysis and multiplier analysis, our approach depends on another crucial assumption. This pertains to assuming that the industrial purchases' coefficients associated with the different programs are constant and invariant over the sample period.

Finally, the approach assumes that consumption of each commodity is linearly dependent on income. Alternatively this assumes that each individual possesses a Cobb-Douglas utility function identical to every other individual. Under such an assumption, relative expenditures on each good would be independent of price changes.

3. Difficulties with the Analytical Approach

There are a number of caveats that apply to this sort of approach. First, the many limitations generally associated with input-output analysis mentioned earlier apply equally to this particular application. Furthermore, the peculiar difficulties associated with the construction of the Ontario input-output tables lend further elements of difficulties. Moreover, the additional assumptions needed to operationalize the functional breakdown of expenditures add new dimensions of error. The assumption that individual utilities are identical and of the Cobb-Douglas type restrict the usefulness of the approach in dealing with price effects. The static nature of the approach should also be mentioned as a limiting factor.

Finally, the Moore concept of the multiplier may be suspect given its deviation from the general concept.

4. The Results

The differential economic impact of these programs was assessed using data for the year 1965. The income and employment effects of a dollar increase in provincial government expenditures classified by program are analyzed and discussed. The results are displayed in Tables 1 and 2.

Interestingly, there exists wide variation in the income effects and multipliers associated with the different programs. When the macroeconomic effects of consumption are considered, the magnitudes of the variations around the mean tend to decrease. This suggests that discriminating expenditure program policies might be employed to increase the income levels of the province, although this conclusion depends upon the specific nature of government's tax policies.

The highest initial income and the highest direct plus indirect income (direct income includes initial income too) are associated with Public Safety and Protection Program. However, when the induced effects are included, Home and Community Program appears to replace Public Safety and Protection as the highest income producing program in Ontario.

Table 1 Provincial Income Effects and Multipliers By Program
(per $10,00 Expenditure)

Effect / Program	Initial Income	Direct & Indirect Income	Direct, Indirect & Induced Income	Income Multiplier (No induced effects)	Income Multiplier (Induced effects included)
Education	7018	9066	9764	1.29	1.39
Transportation & Communication	2644	7211	8764	2.73*	3.31*
Health	6218	8608	9413	1.38	1.51
Social and Economic Welfare	6145	8379	9128	1.36	1.48
Recreation and Culture	4265	8188	9525	1.92	2.23
Home and Community	5859	9058	10147*	1.54	1.73
Industrial Development and Resources	6227	8421	9162	1.35	1.47
General Government	3444	8014	9570	2.32	2.78
Public Safety and Protection	7855*	9102*	9519	1.16	1.21

*The largest value in each column.

These effects represent the ordinary multipliers since the denominator is simply one. They differ, as is demonstrated in Table 1, from the multipliers constructed à la Moore. The new multipliers reveal that Transportation and Communication program has the highest multiplier effect when induced effects are included or excluded.

The manner in which the direct, indirect, and induced effects are utilized here is significant. It is not the magnitude of these income effects that is important, but the spread between these effects and the initial incomes that counts. Thus, whereas the total direct plus indirect effects are largest for the Public Safety and Protection program and the total direct, indirect plus induced effects are largest for the Home and Community program, the highest multiplier effects are generated by the Transportation and Communication program.

The point here may be illustrated in a slightly different way. Suppose that it is desired to generate as large an increase in income as possible at the least initial primary income cost. According to Table 1, the Transportation and Communication program is the expenditure program to implement: for a cost of $2,644 in initial income, it is possible to generate $8,767 of direct, indirect and induced income.

The total income generated by a ten thousand dollars expenditure on any given program is less than ten thousand dollars except for the Home and Community program. It is important to realize that there are several leakages involved when the government increases its expenditures. There are import leakages, tax leakages, and a large initial income component associated with any given expenditure program. Larger tax and import leakages will result in lower potential income generation. Furthermore, the higher the initial income coefficient per unit of expenditure on any given program, the lower is the direct, indirect and induced income generation potential of that program. These general propositions seem to be validated by the results of Table 1.

The wage income effects and multipliers generated by each program in the province as a whole are presented in Table 2 which is organized along the same lines as Table 1. Initial wages are reported separately rather than added to the direct income component. The multipliers are computed in the same manner as those computed in Table 1. The multipliers are effectively lower than those for total income and are also more clustered. Once again expenditures on Education and Health programs generate lower than average multipliers. One likely explanation lies in the high initial wage associated with these programs, leaving a limited income generation potential through industrial purchases.

5. Evaluation of the Results

Organizing expenditures programs by industry represents an improvement over the prevailing literature on this subject which emphasizes the importance of the industrial composition of government purchases, but leaves the impression that these industrial purchases are the direct subject of government choice. Program choice appears to be the main strategic variable whereby government can affect the various economic variables of the system inasmuch as these programs entail different industrial purchases and, therefore, differences in income and employment effects. The analysis has been limited to the comparative statics of the system, but it can easily be extended to include dynamic aspects of the economy in response to a change in the program composition of government expenditures.

The results seem to be consistent with a priori economic reasoning in that induced effects are substantial and they tend to reduce the variance of income generation of different

Table 2 Employment Income and Multiplier by Program (per 10,000 Expenditure)

Effect / Program	Direct and Indirect Employment Income Effect	Direct, Indirect & Induced Employment Income Effect	Employment Multiplier (no Induced Effects)	Employment Multiplier (Induced Effects Included)	Initial Wages
Education	902	1207	1.12	1.17	7018
Transportation and Communication	2480	3153	1.94*	2.19*	2644
Health	1243	1591	1.20	1.25	6218
Social and Economic Welfare	899	1226	1.15	1.20	6145
Recreation and Culture	1724	2304	1.40	1.54	4265
Home and Community	1357	1831	1.23	1.31	5859
Industrial Development and Resources	1065	1388	1.17	1.22	6227
General Government	2613*	3288*	1.76	1.95	3444
Public Safety and Protection	624	807	1.08	1.10	7855*

*The largest value in each column.

programs inasmuch as the consumption relation to income is stable. Furthermore, given the novelty of the multiplier concept used here and the doubts raised about it, it nonetheless answers specific questions and is a multiple of its denominator as one would expect a multiplier to be. This, however, is not true of the ordinary concept.

Obviously, the results and implications revealed here are preliminary and will require substantial refinement before their widespread use in policy making can be realized.

Chapter 7

The Effects of Fiscal Policy Measures in Ontario

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1. Introduction

In this chapter we utilize the inter-regional input-output model constructed in Chapter 3 to compute output and employment "multipliers" from changes in government expenditures and tax rates by the Ontario and Canadian governments. By the term multiplier is meant the percentage change in output or employment by industry (as the case may be) from a given percentage change in government expenditures or tax rates under a set of special circumstances. In particular, the multipliers calculated are short-run multipliers in the Keynesian sense. That is, investment and exports to foreigners are assumed fixed so that the multipliers reflect only induced changes in the consumption components of final demands. In addition, the multipliers are calculated using several limiting assumptions (listed below) about the nature of demand and production responses to comparative static changes. As such, they ought not to be construed as measuring the changes which would actually occur if the fiscal policy changes were undertaken. Rather, they indicate what changes would occur if all the assumptions of the economy held. The changes in output and employment arising from induced changes in investment are not included.

Because the data we are using incorporate the inter-dependencies between regions and industries, the multipliers have an inter-regional feedback mechanism analogous to foreign trade multipliers.[1] That is, changes in Ontario induce changes in consumption in the rest of Canada and vice versa. Therefore, fiscal policy changes will affect demand in Ontario directly as well as affecting it indirectly

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[1] For a general description of the foreign trade multiplier, see Kindleberger (1973).

via its effect on consumption in the rest of Canada. We shall, in fact, compute the relative importance of this feedback mechanism.

Our multipliers for tax changes are, however more elaborate than the usual Keynesian multipliers. The latter assume prices to be fixed whereas the essence of tax policy is to change relative prices. Our model incorporates both the effects of tax changes on consumption via changes in disposable income and the relative price effects of tax changes on consumption into a single multiplier formulation. The mechanism for accomplishing this is the inter-regional input-output table constructed as above. Input-output tables not only incorporate information about resource flows, they can also be used to describe pricing relations. In particular, they can be used to describe how a tax change in one industry works its way through the system to affect prices in all industries. These price changes will differ over commodities and will cause a change in the distribution of consumption over commodities.

To incorporate both disposable income and price change effects on consumption, a Keynesian income determination model will be set up in which aggregate consumption is a function of disposable income, and aggregate consumption is distributed over commodities as a function of relative prices. This model will be used to determine how tax changes in Ontario and the rest of Canada affect output by industry in each region. These output changes can then be used to determine changes in employment by industry, by regions, and by nation.

The assumptions underlying our model will be described next, together with a detailed description of the model and a deriviation of the mutlipliers to be calculated. The mathematical version of the model used in the computation is presented in the Technical Appendix to this Chapter.

2. The Analytical Approach

a. The Assumptions of the Model

In addition to the assumptions that were made in constructing the input-output table, we have to make several other assumptions in order to use that table to analyse changes in the economy. The following list summarizes the assumptions used.

(i) Technology is assumed to be of the Leontief type. That is, all inputs (primary and intermediate) are used in fixed proportions.

(ii) The Keynesian assumption of a perfectly elastic supply of labour is used. The money wage is fixed, and employment is demand-determined. This assumption will be relaxed slightly when the personal income tax is considered. We shall allow the tax to be shifted forward by varying amounts in which case the money wage rate will rise.

(iii) Enough excess capacity exists in all industries such that any changes in demand can be met by adding labour to the existing capital.

(iv) Investment and exports to foreigners are fixed in <u>real</u> terms. Government expenditure is exogenous. Consumption expenditures by each region on each of the region's commodities and on imports from the other region are endogenous and a function of disposable income and relative prices.

(v) The return to capital services in all industries whose corporate tax rate is not changed is fixed. For the industries whose corporate tax rate changes, the rate of return to capital depends upon how much shifting of the tax occurs. Various assumptions are made about the amount of shifting, ranging from zero to full shifting. Exactly the same assumption applies to the wage rate and the personal income tax.

(vi) The Canadian Input-Output Tables are constructed to show the production of commodities by industry. It is assumed that industries provide a constant share of the output of each commodity irrespective of the levels of commodity production. This enables us to convert the Canadian tables into the square industry-by-industry version using the "market shares" matrix. The details of this are given in D.B.S. (1969).

(vii) Aggregate consumption is a linear function of disposable income in each region as in the simple Keynesian model. In turn, it is assumed that the proportion of aggregate consumption by each region spent on each commodity (from both regions) is fixed. It is easy to show that this implies a Cobb-Douglas utility function.[2]

These commodity demand functions being used merit some elaboration. They imply unit price elasticities and unit income elasticities of demand, and are the simplest form of demand function satisfying all the theoretical properties required of demand functions - homogeneity of degree zero in prices and income, and satisfaction of the consumer budget constraint at all sets of prices and income [See Green (1971)]. A tax change which raises

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[2]To show this, assume that the utility function of a typical consumer is:

$$U = AX_1^{\varepsilon i}X_2^{\varepsilon 2}\ldots X_i^{\varepsilon i}\ldots X_\eta^{\varepsilon_\eta}$$

Maximization of utility subject to an income constraint $Y = \Sigma P_i X_i$ yields the following first-order conditions:

$$\frac{\partial U}{\partial X_i} = \varepsilon_i \frac{Y}{X_i} = \lambda P_i \qquad i = 1,\ldots,\eta$$

Therefore,

$$\frac{P_i X_i}{P_j X_j} = \frac{\varepsilon_i}{\varepsilon_j};$$ all i, j. That is, the proportions in which expenditures fall on each commodity are fixed.

final prices and leaves money incomes unchanged initially (e.g., sales tax change) will reduce demands for those commodities whose prices have risen. Real income will have fallen with money income fixed. Note that our model is a "real" one. That is, no constraint is imposed on the ability to raise the price level by money supply considerations.

An alternate way to formulate the problem would be to assume that there are some form of monetary constraints at work which somehow exogenously determine the absolute price level. Changes in taxes could therefore not affect the absolute price level.[3] Demands in this model are a function of relative prices and money income where relative prices are simply absolute prices deflated by the price index. A change in commodity tax which raised prices would also raise the price index and therefore would generally cause only reallocation of consumer expenditures amongst commodities rather than an overall reduction. If the tax increase were general and caused all prices to rise in the same proportion, the tax increase would cause no change in demand. We have rejected this approach to demand functions as being inappropriate for the fiscal policy effects of tax changes and have assumed money to play a passive role.

b. The Calculation of Output Multipliers

The actual computation of multipliers involve some mathematical manipulation of the input-output system and the solution to a set of simultaneous equations using a computer. In this subsection a verbal explanation of these manipulations will be presented. Readers who are interested in the details of the model will find the exact mathematical version used in the computations in the

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[3]This is the type of assumption that is implicitly made in the demand functions of the Candide model[see Schweitzer and Siedule (1973)] and in other work of the authors - Boadway and Treddenick (1975).

Technical Appendix. Because of the fairly complex nature of interactions occurring amongst industries and regions as a result of, say, a tax change, and the simultaneous nature of the formal mathematical solution to the problem, the verbal description presented here cannot do full justice to the computational modelling of the problem. What follows is a discussion of the output multipliers arising from government expenditure changes and each of the various tax changes. The labour employment multipliers are calculated later from the output multipliers.

(i) Government Expenditure Output Multipliers.

The effects of government expenditure changes on output by industry and region provide a simple starting point since they involve no price changes. All the tax changes will involve some changes in prices of industry outputs (both absolute and relative to one another). Therefore, the multipliers derived here are simply "foreign trade" multipliers of the Keynesian sort but from a model with many industries in it.

The essence of the Keynesian multiplier is that increases in government expenditures cause initial increases in output and disposable incomes which in turn induce increases in consumption expenditures out of disposable incomes which cause further increases of smaller magnitude, and so on. We are interested in appending this multiplier process to the inter-regional input-output system. Our entire discussion will be in terms of proportional changes rather than absolute changes. Therefore, the expression rate of change must be taken to mean the proportionate change in the variable involved.

In the input-output tables, the basic relationships influencing the size of changes occurring in the two region's industries are of two sorts. On the one hand, the magnitudes of payments to primary inputs (or changes in those payments) depend upon the outputs produced (or changes in them) since this in turn determines the amounts of primary factors that are employed. Furthermore, since the output by industry (or changes in it) are determined by the final demands for each industry's product (or changes in it) in conjunction with induced intermediate demands as indicated by the input-output structure, the payments to primary inputs depends upon the pattern of final demands. In fact, because the rows and columns of the input-output table add up, total payments to primary inputs must equal total final demands. This summation is called the Gross National Product.

On the other hand, the magnitudes of the final demands are to some extent dependent on payments to primary factors. In our model, consumption expenditures by each region (on products of its own and the other regions) depend upon disposable income in that region (wages and salaries and distributed profits all net of taxes). Therefore, changes in disposable income in a region will cause changes in consumption expenditures in both regions. Because the dependency of primary inputs and final demands runs both ways, and in equilibrium both must be satisfied, the solution for the changes that will occur in final demands and primary inputs must simultaneously satisfy both relationships so that payments to primary inputs and total final demands add up. The algebraic solution to this set of simultaneous equation is straightforward and is given in the Technical Appendix. At this point we shall simply indicate more carefully the nature of the above-mentioned relationships.

When government expenditures change, total output changes for several reasons. First, output must change to meet the increased expenditures. Second, since the outputs require intermediate goods from other industries, there is an induced effect on the outputs of all industries from increasing the output of any one via the inter-industry (and inter-regional) table of coefficients. Third, there will be an induced change in consumption arising from the change in primary inputs to produce increased outputs, and these induced consumption changes will cause further output changes. All these changes can be summarized in a relationship showing the changes in the output of all industries in both regions as a function of changes in consumption and government expenditures (by industry and/or region).

The other dependency, already alluded to, is that showing the induced changes in consumption that would occur from a change in total output. When total output in each industry changes, primary inputs of each of the various types must increase proportionately, because of our assumption above the nature of technology. Therefore, factor payments to each of these sources increase proportionately as well. Not all of these factor payments are available for expenditure. To obtain the changes in disposable income, we include only the change in wage payment net of personal income tax payments at the margin, and changes in that part of the surplus that is distributed as dividends. Since we know the marginal income tax payments by industry and the proportion of surplus distributed by industry, we can obtain the exact relationship between changes in output and changes in disposable income. Since aggregate consumption expenditure is proportional to disposable income by our assumed linear consumption function, the rate of change in aggregate consumption expenditure equals the rate of change in disposable income. Furthermore, since prices have assumed not to have changed and income elasticities are unity, the rate of change in consumption expenditures in each region on all industry outputs of both regions is equal to the rate of change of disposable income in that region. So, we obtain an expression for the change in induced consumption expenditures in each region in terms of the change in output in each region.

Using this latter relationship along with the one derived above and noting that the changes in outputs and consumption expenditures must be the same in both relationships in equilibrium, we can solve the system of equations for the changes in outputs that would occur in the industries of both regions from any change in government expenditures in either or both regions and in any industry. That is, we can obtain the output multipliers arising from changes in government expenditures. These multipliers include all inter-regional feedbacks because they include the effects of induced consumption changes in both regions arising from disposable income changes in both regions. To obtain an indication of the magnitude of the inter-regional feedback effects we may simply recompute all the multipliers for, say, government expenditures in Ontario without allowing any induced consumption in the rest of Canada to occur.

(ii) Output Multipliers from Corporate Tax Changes.

The multiplier effects of corporate income tax changes are more complicated than those of expenditure changes because of the fact that relative price changes result if the corporate tax is shifted forward. We first explain how price changes by industry result from corporate tax changes and then show how these price changes may be incorporated with disposable income changes to determine output multipliers.

The unit price of an industry's output depends upon the unit prices of all the inputs into that industry, both primary and intermediate. Furthermore, as is shown in the Technical Appendix, the rate of change of output price is a weighted average of the rates of change of input prices, the weights being the proportions of total input value made up by each input. When the price of one input changes, the price of the output changes by an amount depending upon the change in the input price and the importance of that input in total value. Because in general each industry's output is an input into other industries, the change in the price of one output will cause further (but smaller) changes in the output prices of all industries.

The Ontario corporate tax is a tax on the returns to capital in all Ontario industries whereas the federal corporate tax is on capital returns in both regions. When the corporate tax changes one of two things may occur or a combination of them. First, the increased corporate tax may be absorbed by the owners of capital in a lower return on capital. In this case, the price of the input "capital" would not change so no output prices would change. The effect of the corporate tax increase would be to reduce disposable income received by capital owners (e.g., dividends) thus inducing a multiple reduction in induced consumption such as in the government expenditure case above.

On the other hand, the corporate tax may be shifted forward in the form of a higher gross return to capital to compensate for the tax increase and leave the net return to capital owners the same. The increase in payments to capital would initially cause all prices to rise by amounts depending on the capital-intensity of the industry involved. And, this would cause a further round of price increases in all industries due to the input-output relations as discussed above. In the end, all prices would have increased but by varying amounts according to the capital intensity of industries and the capital intensity of important inputs into that industry. Unlike the previous case, there would be no initial disposable income reduction resulting from the tax increase. The return to capital-owners does not change.

We term this latter case 100% shifting and the previous case 0% shifting. In between, the corporate tax may be partially shifted in higher prices for capital inputs and partially absorbed in reduced returns to capital owners. Given any degree of shifting, we may compute the price changes that would result and the initial disposable income changes that would result from an increase in the corporate tax in either Ontario or all of Canada. Note that if some shifting occurs, the change in the Ontario tax will nonetheless affect prices in the rest of Canada via increased prices of Ontario inputs. What remains is to incorporate these price and/or disposable income changes into the multiplier formulation.

As before, the economy is one in which everything is determined simultaneously after the initial shock of the tax change. Because of the demand assumptions we have made, there are unit elasticities with respect to income and prices for each product, the rate of change in demand for each commodity equals the rate of change in disposable income less the rate of increase in price. The latter is exogenously determined once the shift parameter is specified. The rate of change in disposable income is comprised of two parts - one is the initial change due to absorption of that part of the corporate tax change which is not shifted forward. The second is the induced change in disposable income generated as above from the increased output to meet the increased final demand. Thus, we obtain a relationship between the change in consumption as a function of the change in disposable income. As above, working the other way we obtain a relation from the input-output tables showing how disposable income changes as a result of changes in final demand. These two sets of relations are solved simultaneously on a computer to yield the change in final demand resulting from a change in corporate tax rates, and then changes in total output (output multipliers).

(iii) Output Multipliers from Personal Income Tax Changes.

The derivation of output multipliers for changes in the rates of personal income tax (Provincial or Federal) is exactly analogous to that of corporate tax changes except that the tax falls on labour payments instead of capital payments. If the tax is shifted forward, it operates by increasing the wage rate paid by industries and this causes all prices to rise.[4] If the tax is not shifted, the wage rate does not change and all the tax change is absorbed in disposable income changes. Given any degree of shifting, the price changes by industry and initial disposable income changes can be ascertained and the multiplier effects of these may be computed as described above for corporate tax changes. As before, the Technical Appendix presents the mathematical derivation of the multipliers.

(iv) Output Multipliers from Commodity Tax Changes.

Commodity taxes must be distinguished according to whether they fall on intermediate use or on final demand (or both). Those falling on final demand will cause the price to final demanders to rise for the commodity being taxed. Those falling on intermediate use will induce increases in the price of all other commodities via the input-output relationships. In either case the rise in price of products will cause an initial fall in consumption expenditures which, in turn, will induce final reductions in consumer expenditures via the multiplier effects. These reductions will generally occur in both regions even though the initial change in price may have occurred only in one. Furthermore, because different tax changes have very different effects on relative price changes, the impacts of different taxes need not be identical.

(v) Employment Multipliers.

In the preceding subsections we discussed the computation of output multipliers from changing various tax

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[4]By assuming fixity of factor prices in the face of increases in goods prices but allowing for the possibility of some shifting of personal income taxes forward in higher wages, we are implying that some "tax illusion" may be present. A more elaborate treatment might allow for some reaction of wage payments to goods price increases caused by tax increases.

rates and government expenditures. These multipliers show the change in output in each industry in each region arising from a given fiscal policy change. From these changes in industry outputs, we may compute the rates of change in labour demand by industry, by region, and for all of Canada.

If we assume that all types of labour are used in fixed proportions in each industry, the rate of change in labour demand will equal the rate of change in wage payments. From the input-output tables we obtain the relationship between wage payments and total output. The rate of change in wage payments by industry may be obtained from the change in output as given by the output multipliers. Thus, we obtain the rate of change of labour demand by industry from each of the fiscal policy measures.

From the rates of change of labour demand by industry we can obtain overall rates of change of labour demand by region by taking a weighted average of labour demand changes by industry in each region, the weights being the share of labour in each industry. Similarly, we may obtain the aggregate rate of change in labour demand for all of Canada by aggregating the rates of change in the two regions.

3. Difficulties With the Approach

There are two broad categories of difficulties with applying the analytical approach outlined above. The first is that the assumptions we have made regarding technology, demand, and price formation may not correspond to their real world counterparts. The other is the more general methodological problem involved in dealing solely with short run (static) effects and ignoring long run (dynamic) effects. We may comment briefly on both of these.

Subsection 2(a) above outlines the assumptions we have made about technology (fixed proportions with elastic labour supplies and excess capacity) and demand (constant expenditure proportions for each product and a linear aggregate consumption function). These assumptions are essentially dictated by the availability of data. The input-output tables provide us with only one observation so there is no way we may infer what the input-output relations would look like if a change occurs in the economy. This applies not only to the intermediate input-output coefficients but also to the primary input coefficients and the dividend payout ratios which determine changes in disposable incomes. It could be argued that, to the extent that the changes being considered are only short-run changes, the dividend payout ratios and the wage coefficients overstate their actual short-run marginal values. That is, in the short-run, dividend payouts may be relatively fixed. As well, increases in output may be accomplished with smaller additions to the labour force per unit of output than average. Unfortunately, the available data do not allow us to obtain reliable estimates of the short-run marginal payout ratios and wage coefficients. Therefore, we use the corresponding average variables which are readily available. This is, of course, standard input-output practice. It might be noted that if marginal wage coefficients differed from the average an additional problem arises in that a change in output would cause a change in wage coefficients which would entail either a change in output prices or a change in one of the other coefficients (most likely the surplus coefficients). This would complicate matters considerably. In any case, such overstatement of changes in disposable income as may occur is partly cancelled out since all our experiments would include the same overstatement. If marginal and average values of dividend payout ratios and wage coefficients differed by the same extent over all industries, the comparative effects of different tax and expenditure changes would not be affected.

The other problem is not a problem of shortage of data but one of interpreting the results. Short-run or Keynesian multipliers are never observed since investment and exports never stay constant while the multiplier is working its way through the economy. This process may take several months. Therefore, the resulting multipliers give only a partial picture of what the effects of fiscal policy changes might be on the economy. They give only those effects due to induced consumption changes and ignore any induced effects on investment. To the extent that investment behaviour may be approximated by the acceleration principle (investment is a function of changes in income), the short run multiplier effects would underestimate the ultimate impact of fiscal policy changes. On the other hand, we have completely ignored the monetary sector in computing these multipliers by implicitly assuming a passive money supply. This is not realistic in the case of Ontario fiscal policy changes. If changes in the money supply by the Bank of Canada do not respond passively to activity induced by Ontario fiscal policy, the multiplier process will be retarded and our multipliers would overstate the short run effects of Ontario fiscal policy.

4. Results

Computations of the labour demand multipliers were performed for the following sets of taxes - Ontario corporate and personal income taxes, Ontario retail sales tax, Ontario gasoline tax, Federal corporate and personal income taxes, Federal Manufacturing sales tax, Federal Building Materials tax, Federal Alcohol tax, and Federal Tobacco tax. As the Technical Appendix shows, in order to compute the effects of rates of change in taxes, the original tax rates must be known. We first briefly describe how the tax rates for each of the above were obtained. The actual tax rates computed are given in the Data Appendix. In addition, other miscellaneous data must be known as outlined below and reported in the Data Appendix.

a. Ontario and Federal Corporate and Personal Income Tax Rates

The corporate tax rates used in this study are computed by taking total tax payments by industry and dividing them by gross surplus. They are therefore not the same as the legal rates which are given as proportions of taxable profits. The input-output surplus item given is not disaggregated into its component parts (e.g., taxable income, depreciation, taxes, etc.). In any case, no single statutory rate applies to all enterprises within an industry since they are of different sizes and pay different rates. We therefore use as a base for our average corporate tax rates by industry the gross surplus, and our analytical procedure has been based on the use of that rate. Figures for total Federal corporate taxes paid by industry in 1966 are readily available from D.B.S. Corporate Taxation Statistics 1966. These are aggregated to our 16 industries and divided by the surplus for each industry (from the 1966 Canadian Input-Output Tables) to give the corporate tax rates.

To obtain Ontario corporate tax rates, we must assume that the provincial corporate tax rates by industry are the same as the average for all provinces. This is because the provincial corporate tax payments in D.B.S. Corporate Taxation Statistics are listed only for all provinces as an aggregate and not for each province separately. The Ontario provincial corporate tax rates by industry were therefore approximated by dividing total provincial tax payments by gross surplus in the Canadian Input-Output Tables.

To obtain personal income tax rates paid by industry employees, average weekly wages for July, 1966 are used as given by D.B.S. Review of Employment and Payrolls 1966. These are available both for all of Canada and for Ontario. Those given for all of Canada were assumed to be also applicable to the rest of Canada (not including Ontario). Using these average weekly wages and assuming that the average worker is married with two children, the marginal federal tax rate payable on this average wage by industry for the two regions is obtained from D.B.S. Principal Taxes and Rates. For Ontario industries the marginal provincial tax paid is found by taking 23% of the Federal rate.

b. Ontario and Federal Commodity Tax Rates

The major difficulty in obtaining commodity tax rates was to arrive at effective *ad valorem* tax rates consistent with the industrial classification of the input-output tables. Statutory rates on commodities are readily available but because of exemptions, tax rate changes, etc., these bear little resemblance to effective rates. Therefore, where possible our rates are computed on the basis of actual tax collections. Industry tax rates were obtained by weighting appropriate commodity rates by the proportions of commodity outputs in each industry's output. Where tax collections by commodities were not available, such as in the case of the Ontario retail sales tax, statutory rates on commodities were used and weighted in a similar manner to obtain industry tax rates. Details on the construction of specific rates follow.

(1) Federal Commodity Taxes

(i) Alcohol

Federal excise duties on alcohol are specified amounts per unit on specified products. To obtain the appropriate *ad valorem* rate we have taken total tax collections on alcohol as a proportion of total final demand less exports for Industry 4 (Food, Feed, Beverage and Tobacco Industries). The tax revenues were obtained from Canadian Tax Foundation, The National Finances 1968-69, Table 21. Final demand expenditures were obtained from the input-output tables.

(ii) Tobacco

Both ad valorem excise taxes and specific excise duties apply to tobacco products. The equivalent ad valorem rate was obtained in the same manner as that for alcohol products.

(iii) General Manufacturers' Sales Tax

Commodity tax payments (less provincial retail sales taxes) on an intermediate and final demand basis were obtained directly from the Structural Analysis Division, Statistics Canada. An estimate of the general manufacturers sales tax payments was obtained as a residual after eliminating other identifiable intermediate and final demand tax payments such as alcohol and tobacco taxes and gasoline taxes. These tax payments were converted into intermediate and final demand tax rates by dividing by appropriate industry total outputs and final demands.

(iv) Building Materials Tax

Commodities subject to the federal sales tax on building materials were identified from the Excise Act. The proportions of each industry total output represented by these commodities were then computed. These proportions were then applied to the intermediate and final demand commodity tax flows described in (iii) above to obtain appropriate tax rates on building materials on an industry basis.

(2) Ontario Commodity Taxes

(i) Retail Sales Tax

Because data on retail sales tax collections by commodity are not available for Ontario, it was necessary to use the statutory rates. Commodities subject to the retail sales tax were identified. The proportions of each industry final demand in Ontario represented by these commodities were calculated and applied to the statutory rates to obtain equivalent retail sales tax rates on an industry basis. Because the Ontario sales tax on commodities increased from three per cent to five per cent on April 1, 1966, a weighted average of 4.5 per cent was used as the appropriate commodity rate.

(ii) Gasoline Tax

The Ontario gasoline tax is a specific tax per gallon. To obtain the equivalent, effective ad valorem rate total gasoline tax revenues were divided by the total use of outputs from industry 10 as inputs into all Ontario industries and for Ontario final demands. It is assumed that the proportion of this total use which is subject to the gasoline tax is constant. Gasoline tax revenues were obtained from Canadian Tax Foundation, Provincial Finances, 1967, table 52.

c. Miscellaneous Items

(i) Surplus Distribution Coefficients

Surplus distribution coefficients were obtained as the ratio of distributed dividends to gross surplus on an input-output basis for each industry with identical coefficients being used for Ontario and the remainder of Canada. Data on distributed dividends was obtained from D.B.S. Corporation Financial Statistics, 1966.

(ii) Personal Disposable Income

Personal disposable income for Ontario ($16,159.9 million) and the remainder of Canada ($23,741.1 million) were obtained from Statistics Canada, System of National Accounts - National Income and Expenditure Accounts, 1970.

(iii) Industry Labour Shares

Labour employment by industry for Ontario and the remainder of Canada was obtained from D.B.S. Review of Employment and Payrolls, 1966, and aggregated into the sixteen industry classification used in the model.

For each type of tax we had to compute labour demand multipliers for only one percentage change in the tax rate. The multipliers for all other magnitudes of tax rate changes are proportional (e.g., multipliers from a 20% change in the tax rate are twice as big as multipliers for a 10% change in the tax rate). In addition, for the corporate and personal income tax changes, we had only to do the computations for two different shift parameters. Multipliers for all other shift parameters are linear extrapolations from the two used. In our case, we used the extreme shifting assumptions - 0% and 100%. Therefore, 50% shifting gives multipliers mid-way between those two, etc.

All tax rate computations were done for increases in the rates by 20%. Doing so does not make various tax changes comparable since a 20% change in various taxes raises different amounts of revenue. In order to compare the magnitudes of impact of different taxes in comparable circumstances, we would need to know the total amount of tax revenue generated (direct and indirect) when each tax is changed. Unfortunately, we do not have the information available to determine this. Instead, we shall, as a first approximation to that, compare tax changes for Ontario which have the same initial impact on revenues from that source.

In addition, for each of the Ontario taxes, labour demand changes were computed in a model in which no feedback of demand from the rest of Canada existed. To do this, the above model was applied to the Ontario input-output tables above and consumption changes in the rest of Canada were all set to zero. Comparison of these results with the previous ones gives an indication of the importance of feedback effects for Ontario fiscal policy.

In the following sections the results from all of these tax changes are presented. In many cases the figures speak for themselves. General comments will be made on some of the more interesting results. All results are given in terms of the 16 industry aggregation of the Canadian input-output tables. These industries are listed in Table 1.

A. Ontario Corporate Tax Changes

Table 2 presents the labour demand multipliers resulting from a 20% change in the Ontario corporate tax rate both when interregional effects are allowed for and omitted. The effect of these tax changes on employment in the rest of Canada is omitted because it is insignificant. The most striking point to note is that the effects are very small. Recall that we are including only induced consumption changes and not induced investment changes. Thus, the longer run effects of the corporate changes would be expected to be greater.

The main reason for these low multipliers is that the effective corporate tax rate as a proportion of gross surplus is quite small and therefore is a very small component of final price. As well, changes in disposable income from changes in the tax rate will be very small, especially since only the distributed part of surplus is included in disposable incomes.

As the shifting parameter increases, the multipliers also increase. The reason for this is as follows. As shifting increases, the corporate tax change works more through increasing prices and less through reducing distributed profits. The price change effects are apparently stronger than the reduced distributed profits effects presumably because only a small proportion of the tax increase comes from distributed profits. The bulk comes from other items in gross surplus which do not enter into disposable incomes.

TABLE 1

THE SIXTEEN INDUSTRY AGGREGATION USED IN THIS STUDY

Industry Number	Name
1	Agriculture, Forestry, Fishing & Trapping
2	Mines & Quarries (Excl. coal)
3	Mineral Fuel Mines & Wells
4	Food, Feed, Beverage & Tobacco
5	Textiles
6	Wood & Furniture
7	Paper and Allied Industries
8	Primary Metal & Metal Fabricating
9	Transportation & Electrical Equipment
10	Chemical, Rubber, & Petroleum Products
11	Other Manufacturing
12	Construction
13	Transportation, Storage & Trade
14	Electric Power, Gas & Water Utilities
15	Communications & Other Service Industries
16	Miscellaneous Operating Costs (Dummy)

The industries which are most affected (proportionately) by the tax change are 4 (Food, Feed, Beverage and Tobacco), 9 (Transport and Electrical Equipment), and 15 (Communications and Services). It is difficult to say why this is so since everything depends upon the input-output structure. However, it is interesting to note that 4 and 15 are consistently the most affected industries in all tax cases. One reason for this might be that a relatively high proportion of their total output goes to consumption final demand compared with other industries.

Table 2 also gives the employment multipliers for Ontario when no interregional feedbacks exist. As expected, the multipliers are smaller because no allowance has been made for the effect of induced changes in demand (both final and intermediate) by the rest of Canada on Ontario products. However, the differences are not large due to the minimal affect this tax change has on the output in the rest of Canada. The differences are greater the more shifting there is indicating once again the relative strength of price versus disposable income effects.

B. Federal Corporate Tax Changes

Federal corporate tax multipliers for Ontario and the rest of Canada under the two shifting assumptions are shown in Table 3. The magnitudes of these are much larger (almost ten times as large) owing mostly to the higher tax rate but also partly to the fact that Federal tax changes hit both regions whereas Ontario changes do not. The multipliers are approximately the same size in both regions.

Those industries which are most strongly affected are once again 4 (Food, Feed, Beverage and Tobacco), 9 (Transport and Electrical Equipment), 15 (Communications and Services) and, this time, 5 (Textiles). The same statement as above applies here.

Table 2

EMPLOYMENT EFFECTS OF INCREASING THE ONTARIO CORPORATE INCOME TAX RATE BY 20 PERCENT WITH AND WITHOUT INTERREGIONAL FEEDBACK EFFECTS

(Percentage Changes)

Industry	SHIFTING ASSUMPTION 0.0%		100.0%	
	With Feedback	Without Feedback	With Feedback	Without Feedback
1	-0.01	-0.01	-0.04	-0.03
2	0.00	0.00	-0.01	0.00
3	0.00	0.00	0.00	0.00
4	-0.02	-0.02	-0.07	-0.05
5	-0.01	-0.01	-0.06	-0.03
6	-0.01	-0.01	-0.02	-0.02
7	-0.01	-0.01	-0.02	-0.01
8	0.00	0.00	-0.02	-0.01
9	-0.01	-0.01	-0.06	-0.04
10	-0.01	-0.01	-0.05	-0.03
11	-0.01	-0.01	-0.03	-0.02
12	-0.01	-0.01	-0.01	-0.01
13	-0.02	-0.02	-0.05	-0.04
14	-0.02	-0.02	-0.05	-0.04
15	-0.03	-0.03	-0.07	-0.07
16	0.00	0.00	0.00	0,00
Total	-0.01	-0.01	-0.05	-0.04

Table 3

EMPLOYMENT EFFECTS OF INCREASING THE FEDERAL CORPORATE INCOME TAX RATE BY 20 PER CENT

(Percentage Changes)

Industry	SHIFTING ASSUMPTION 0.0%		100.0%	
	Ontario	Rest of Canada	Ontario	Rest of Canada
1	-0.12	-0.12	-0.36	-0.34
2	-0.02	-0.06	-0.08	-0.17
3	0.00	-0.10	-0.01	-0.33
4	-0.20	-0.23	-0.69	-0.73
5	-0.21	-0.22	-0.67	-0.58
6	-0.10	-0.07	-0.25	-0.16
7	-0.07	-0.06	-0.23	-0.19
8	-0.05	-0.08	-0.17	-0.21
9	-0.11	-0.07	-0.52	-0.20
10	-0.12	-0.16	-0.50	-0.52
11	-0.09	-0.10	-0.31	-0.26
12	-0.05	-0.01	-0.12	-0.04
13	-0.15	-0.16	-0.49	-0.49
14	-0.21	-0.12	-0.46	-0.28
15	-0.23	-0.18	-0.59	-0.41
16	0.00	0.00	0.00	0.00
Total	-0.13	-0.13	-0.43	-0.37

Notice that, as with the Ontario corporate tax change, as the shifting increases so do the multipliers. This is an indication that price effects from corporate tax changes are stronger than disposable income effects.

C. Ontario Personal Income Tax Changes

The labour demand multipliers from a 20 per cent change in the Ontario personal income tax in the interregional model are shown in Table 4. Note that the effects are much larger than those from the Ontario corporate tax, (in many cases ten times as high). As well, the effects on the rest of Canada are larger than before but still only 1/10 of the effects on Ontario.

As shifting increases, the multipliers become smaller, unlike the corporate tax case. This indicates that the direct disposable income reducing effects from personal tax changes are stronger than any price effects, due to increased gross wages. This difference from the corporate tax case arises because all reductions in wage payments due to an increase in personal taxes not shifted forward are equivalent to reduced disposable incomes.

The industries most affected in Ontario by the personal tax increase are 4 (Food, Feed, Beverage, and Tobacco), and 15 (Communications and Services) as before as well as 13 (Transportation, Storage and Trade) and 14 (Utilities). This may be partly due to the fact that 13 and 15 have large wage coefficients. But, as before, since everything goes through the input-output table, cause and effect is not easy to pin-point.

Table 4 also gives the Ontario labour demand multipliers when interregional feedbacks are neglected. Once again the multipliers are smaller than before. As the shifting

Table 4

EMPLOYMENT EFFECTS OF INCREASING ONTARIO PERSONAL INCOME TAX RATES BY 20 PER CENT WITH AND WITHOUT INTERREGIONAL FEEDBACKS

(Percentage Changes)

Industry	S H I F T I N G	A S S U M P T I O N				
	0.0%			100.0%		
	Ontario	Rest of Canada	Without Feedback	Ontario	Rest of Canada	Without Feedback
1	-0.19	-0.05	-0.18	-0.13	-0.03	-0.10
2	-0.02	-0.01	-0.02	-0.02	-0.01	-0.01
3	0.00	-0.06	0.00	0.00	-0.04	0.00
4	-0.30	-0.06	-0.29	-0.23	-0.04	-0.16
5	-0.23	-0.14	-0.21	-0.23	-0.07	-0.12
6	-0.15	-0.03	-0.14	-0.13	-0.01	-0.10
7	-0.08	-0.03	-0.08	-0.07	-0.02	-0.05
8	-0.06	-0.01	-0.05	-0.05	-0.02	-0.03
9	-0.14	-0.03	-0.13	-0.14	-0.02	-0.09
10	-0.15	-0.05	-0.14	-0.13	-0.03	-0.08
11	-0.11	-0.02	-0.10	-0.12	-0.02	-0.07
12	-0.09	0.00	-0.09	-0.06	0.00	-0.05
13	-0.27	-0.02	-0.27	-0.23	00.02	-0.21
14	-0.40	-0.01	-0.39	-0.22	-0.01	-0.20
15	-0.46	-0.01	-0.46	-0.29	-0.01	-0.27
16	0.00	0.00	0.00	0.00	0.00	0.00
Total	-0.22	-0.03	-0.22	-0.17	-0.02	-0.14

parameter increases, the difference between the two cases increases. With full shifting, the multipliers are nearly 20 per cent higher with interregional feedbacks. Thus, neglect of interregional feedbacks can lead to serious underestimates of the impact of Ontario fiscal policy.

D. Federal Personal Income Tax Changes

Changes in the Federal personal income tax has much larger effects than the Ontario case, and much larger than corporate tax changes mainly due to higher effective tax rates. The multipliers are shown in Table 5. But also, Federal tax changes affect both regions whereas Ontario tax changes alone affect only Ontario and thus have substantial leakages.

As with the Ontario tax change, Federal personal income tax multipliers decrease as more shifting is assumed. This indicates the relatively stronger impact of disposable income effects compared with price effects.

Those industries affected most are 4 (Food, Feed, Beverage and Tobacco), 5(Textiles), and 15(Communications and Services) in both regions; 13 (Transportation, Storage, and Trade) in the rest of Canada; and 14 (Utilities) in Ontario. Once again, the sensitivity of 4 and 15 in both regions is apparent. As well, 5 seems to be important for Federal tax changes but not for Ontario. This may reflect the dependence of Ontario on textile imports from the rest of Canada (especially Quebec).

E. Ontario Commodity Taxes

The labour demand multipliers from a 20 per cent rise in the Ontario Retail Sales Tax are shown in Table 6 for both the interregional and non-interregional cases. The magnitude of the multipliers seem relatively low (0.13% for Ontario

Table 5

EMPLOYMENT EFFECTS OF INCREASING FEDERAL

PERSONAL INCOME TAX RATES BY 20 PER CENT

(Percentage Changes)

	SHIFTING ASSUMPTION			
Industry	0.0%		100.0%	
	Ontario	Rest of Canada	Ontario	Rest of Canada
1	-1.26	-1.59	-0.86	-0.86
2	-0.28	-0.85	-0.18	-0.46
3	-0.02	-1.24	-0.02	-0.69
4	-2.19	-2.98	-1.48	-1.61
5	-2.35	-2.68	-1.68	-1.75
6	-1.10	-0.84	-0.83	-0.61
7	-0.77	-0.78	-0.53	-0.47
8	-0.55	-1.09	-0.37	-0.58
9	-1.19	-0.92	-0.91	-0.52
10	-1.39	-2.08	-0.92	-1.06
11	-1.05	-1.26	-0.80	-0.72
12	-0.44	-0.20	-0.31	-0.11
13	-1.43	-2.19	-1.27	-1.39
14	-1.99	-1.60	-1.21	-0.76
15	-2.19	-2.40	-1.55	-1.09
16	0.00	0.00	0.00	0.00
Total	-1.37	-1.77	-1.03	-1.00

Table 6

EMPLOYMENT EFFECTS OF INCREASING THE

ONTARIO RETAIL SALES TAX BY 20 PER CENT

(Percentage Changes)

	With Interregional Effects		Without Interreginnal Effects
Industry	Ontario	Rest of Canada	Ontario
1	-0.06	0.02	-0.06
2	-0.02	-0.01	-0.02
3	0.00	-0.05	0.00
4	-0.13	-0.02	-0.13
5	-0.51	-0.07	-0.50
6	-0.23	-0.01	-0.23
7	-0.09	-0.01	-0.09
8	-0.07	-0.01	-0.07
9	-0.26	-0.01	-0.26
10	-0.17	-0.02	-0.17
11	-0.12	-0.01	-0.12
12	-0.02	0.00	0.02
13	-0.08	-0.01	-0.08
14	-0.08	-0.01	-0.08
15	-0.07	-0.01	-0.07
16	0.00	0.00	0.00
Total	-0.13	-0.01	-0.12

employment change) for such a large change in the tax (e.g., from 5% to 6%). The multipliers tend to be larger than the corporate tax case and smaller than the personal income tax case.

The industries bearing the strongest impacts are 5 (Textiles), 6 (Wood and Furniture), and 9 (Transport). This may be easily accounted for by the fact that these industries bear relatively high effective sales tax rates.

Note that the employment in the rest of Canada is hardly affected by changes in the Ontario sales tax. This is further borne out by looking at the results when no interregional feedbacks exist. The multipliers are only barely smaller. This may be because the initial impact of changes in the Ontario retail sales tax is to reduce final demand for Ontario commodities leading to a reduction in intermediate purchases from both regions. There is only a secondary change in disposable incomes affecting final demand purchases from the rest of Canada.

The employment multipliers from the Ontario Gasoline Tax are given in Table 7. These multipliers are surprisingly high - two and a half times larger than the retail sales tax, and roughly the same as for the Ontario personal income tax. This is partly due to the high rate base and partly due to the fact that the gasoline tax hits intermediate purchases as well as final demand so is diffused throughout the economy. In addition, as Tables 6 and 7 indicate, the relative impact of the gasoline tax on industries 13 and 15 is very large compared with the impact of the retail sales tax. These industries (Transportation, Storage, and Trade, and Communications and Other Services) are relatively labour-intensive and employ a disproportionately large proportion of Ontario's labour force (22.4% and 17.2% respectively). Therefore, a tax which strikes these industries relatively heavily is bound to have relatively

Table 7

EMPLOYMENT EFFECTS OF INCREASING THE

ONTARIO GASOLINE TAX BY 20 PER CENT

(Percentage Changes)

Industry	With Interregional Effects		Without Interregional Effects
	Ontario	Rest of Canada	Ontario
1	-0.30	-0.10	-0.22
2	-0.05	-0.04	-0.03
3	-0.01	-0.14	0.00
4	-0.53	-0.15	-0.36
5	-0.44	-0.18	-0.23
6	-0.23	0.05	-0.16
7	-0.14	-0.05	-0.09
8	-0.10	-0.05	-0.06
9	-0.26	0.05	-0.16
10	-0.43	-0.11	-0.26
11	-0.20	-0.06	-0.12
12	-0.10	-0.01	-0.09
13	-0.34	-0.08	-0.29
14	-0.45	0.05	-0.40
15	-0.50	-0.07	-0.46
16	0.00	0.00	0.00
Total	-0.31	-0.07	-0.20

large labour demand multipliers.

The industries most strongly hit by a gasoline tax increase are 4 (Food, Feed, Beverage, and Tobacco) 5 (Textiles), 10 (Chemical, Rubber and Petroleum), 14 (Utilities), and 15 (Communications and Services). The effect on 10 is easy to explain since gasoline is one of the final demands of industry 10. The remaining industries may be relatively "gasoline-intensive" in their use of intermediate inputs. This is certainly true of 14.

The interregional effects of the Ontario gasoline tax are much stronger than that of the retail sales tax. Without interregional flows, the multipliers are a full third smaller for the former. Indeed, the differential between the impacts of the two taxes is narrowed considerably. In this case, neglect of interregional feedbacks can cause a serious underestimate of the strength of Ontario fiscal policy.

F. Federal Commodity Taxes

The labour employment effects in Ontario from changing various Federal commodity taxes is shown in Table 8. The effects on the rest of Canada employment are in Table 9. The effects on the two regions are roughly the same (proportionately).

The Federal Manufacturers Sales Tax has the largest multipliers of any taxes. It has fairly large rates and pervades the entire economy. Those industries most affected are 4 (Food, Feed, Beverage, and Tobacco), 5 (Textiles), 10 (Chemical, Rubber, and Petroleum), and 15 (Communications and Services). There is no intuitively obvious reason why this is the case.

Table 8

ONTARIO EMPLOYMENT EFFECTS OF INCREASING

SELECTED FEDERAL COMMODITY TAX RATES

BY 20 PER CENT

(Percentage Changes)

Industry	General Manufacturers Sales Tax	Tobacco Excise Taxes	Alcohol Excise Taxes	Sales Tax on Building Material
1	-2.84	-0.30	-0.27	-0.46
2	-0.58	0.02	0.02	-0.08
3	-0.06	0.00	0.00	-0.01
4	-5.22	-0.72	-0.65	-0.80
5	-5.54	0.05	0.04	-0.76
6	-2.19	0.03	0.03	-0.35
7	-1.57	-0.09	-0.08	-0.24
8	-1.12	0.03	0.03	-0.17
9	-2.81	0.03	0.03	-0.40
10	-3.81	-0.07	-0.07	-0.46
11	-2.17	-0.05	0.05	-0.32
12	-0.80	0.02	0.02	-0.14
13	-2.70	-0.08	-0.07	-0.46
14	-3.43	-0.07	-0.06	-0.60
15	-3.74	-0.06	-0.05	-0.67
16	0.00	0.00	0.00	0.00
Total	-2.78	-0.09	-0.08	-0.44

Table 9

REST OF CANADA EMPLOYMENT EFFECTS OF INCREASING

SELECTED FEDERAL COMMODITY TAX RATES

BY 20 PER CENT

(Percentage Changes)

Industry	General Manufacturers Sales Tax	Tobacco Excise Taxes	Alcohol Excise Taxes	Sales Tax on Building Materials
1	-2.84	-0.31	-0.28	-0.43
2	-1.30	-0.03	-0.02	-0.21
3	-2.83	-0.06	-0.05	-0.34
4	-5.85	-0.92	-0.82	-0.85
5	-5.74	-0.06	-0.05	-0.75
6	-1.51	-0.03	-0.02	-0.23
7	-1.39	-0.08	-0.07	-0.21
8	-1.77	-0.03	-0.03	-0.27
9	-1.66	-0.02	-0.02	-0.22
10	-4.82	-0.09	-0.08	-0.53
11	-2.15	-0.05	-0.04	-0.31
12	-0.28	-0.01	-0.01	-0.05
13	-3.08	-0.08	-0.07	-0.52
14	-2.02	-0.06	-0.05	-0.33
15	-3.01	-0.06	-0.05	-0.51
16	0.00	0.00	0.00	0.00
Total	-2.81	-0.11	-0.10	-0.43

The tobacco tax and the alcohol tax are as expected. Both have small multipliers and both hit industries 4 (Food, Feed, Beverage, and Tobacco) and 1 (Agriculture, Forestry, Fishing and Trapping). This is because both taxes fall on the output of industry 4 for final use and both Tobacco and Alcohol rely heavily on industry 1 for intermediate inputs.

Finally, the Building Materials Tax (which is also part of the Manufacturers Sales Tax) has a fairly large impact on employment. A 20 per cent increase in rate (say, from 11% to 13.2%) causes a .44% fall in labour demand in Ontario and .43% in the rest of Canada. Those industries most affected are 4 (Food, Feed, Beverage, and Tobacco), 5 (Textiles), and 15 (Communications and Services). Note that the reason why 12 (Construction) is not that heavily affected is that residential and industrial building subject to this tax falls under investment, so is assumed unchanged. As with the corporate tax, the Building Materials Tax can be expected to have much larger long run effects due to its effect on investment.

G. Comparative Effects of Ontario Tax Changes - A First Approximation

In comparing the various Ontario tax instruments as to their relative effectiveness for short run stabilization, it would be desirable to compare tax changes which yield the same tax revenues to the government. As a first approximation to that, we can compute the effect on tax revenues of a tax change from each source by taking total tax collections for year 1966 and multiplying them by the tax rate change (20% in our case). The initial effect is the rise in tax collection which would occur if tax rates changed but all output of the economy did not. Since the latter changes were for tax changes which have the strongest impact and since larger output changes would probably reduce tax collection more, the comparative fiscal effects of tax changes with the same impact effect on tax revenues will under-estimate the fiscal policy differences between tax changes which yield the same change in tax revenue from each source. Furthermore, a change in one tax will generally cause tax revenues from other sources to change. These tax revenue changes are also being ignored thereby likely tending to bias the differences downward even more.

The total tax revenues collected in Ontario in 1966 from each of the four sources are as follows:

Personal income tax	\$348.1 million
Corporation income tax	\$254.5 million
Retail sales tax	\$349.2 million
Gasoline tax	\$268.6 million

(Source: Canadian Tax Foundation, Provincial Finances - 1967) Notice that the magnitudes of these revenue sources are fairly similar so that our multipliers from 20% tax changes computed earlier have similar impact effects. To make the impact effect identical a 20% change in the personal income tax would be equivalent to a 27% change in the corporate tax, a 20% change in the retail sales tax, and a 26% change in the gasoline tax. The Ontario labour demand multipliers with interregional feedback for these tax changes are as follows:

Personal income tax	Zero shifting	-.22
	50% shifting	-.20
	100% shifting	-.18
Corporate income tax	Zero shifting	-.02
	50% shifting	-.09
	100% shifting	-.06
Retail sales tax		-.13
Gasoline tax		-.36

As can be seen, the gasoline tax continues to have the largest relative impact. The personal income tax and the retail sales tax have very similar impacts on employment whereas the corporate tax has a relatively minor impact.

5. Evaluation of Results

The computations of short run employment multipliers in this study has shown that different taxes have widely varying impacts, and tax changes have very uneven effects across industries. It appears as if the Ontario taxes with the largest effect is the gasoline tax, followed by the personal income and retail sales taxes. The corporate income tax has a very small short run effect on labour demand. Even at that, the effect of the corporate tax may be overstated to the extent that firms may not vary their dividend payout ratios in the short run. It is also apparent that the brunt of the effect of Ontario tax changes is on Ontario industries. The effects on industries in the rest of Canada are very small. The Federal tax changes with the most effect on Ontario are the Manufacturers Sales Tax and the personal income tax. The Building Materials Tax also has a fairly large impact.

Some industries have consistently higher proportionate employment changes than others. Industries 4 (Food, Feed, Beverage and Tobacco), and 15 (Communications and Services) are consistently more strongly affected than others from both Ontario and Federal tax changes. As well, industry 5 (Textiles) is strongly affected by most Federal tax changes.

It is apparent that further work in this area is required. In order to compare different taxes, it would be desirable to compare different tax changes yielding the same total tax revenue to, say, the Ontario government. This was too complicated an undertaking to do in the time available for this project. To compute the tax revenue from a change in any single tax requires computing changes in tax revenues from all sources of revenue using the input-output table. Changing total tax revenue is only one half of the picture. As well, it would be useful to change some taxes selectively by industry (e.g., the corporate tax case) to obtain different employment multipliers. Government expenditure changes could be undertaken at the same time and such things as balanced budget multipliers could be calculated. Some longer run effects and capacity or labour supply constraints could be incorporated into the problem. And, finally, more sophisticated demand assumptions could be made.

The real limitation on this study and on any extensions is in the deficiency of the data. The computations of this model have been based on a great deal of underlying data, much of it arrived at by ad hoc assumptions. The biggest need is for better data especially in the following areas:

(i) The value added in the Ontario input-output tables should be disaggregated into net surplus, wages, depreciation, and tax components.

(ii) Data on tax collections by industry for the various commodity taxes should be tabulated. This is necessary in order to make more accurate estimates of the tax rates.

(iii) Data should be collected on import flows between Ontario and the rest of Canada as well as Ontario and foreign sources.

(iv) It would be very useful if the existing Ontario input-output tables were done in the interregional form either as above or using more regions. It should be made as disaggregated as possible. For example, taxes on gasoline apply only to a fraction of the total output of industry 10. To consider the gas tax effects properly, gasoline output should be disaggregated from the rest of industry 10 commodities.

Chapter 8

Differential Sub-Regional Impact of Ontario Provincial Government Expenditures

A. A. Kubursi

1. Introduction

In this chapter we consider the feasibility of reducing regional income disparities by selective expansion of particular government expenditure programs. This was motivated by certain policy issues in the Ontario economy arising from observed per capita income disparities as well as differential employment opportunities among the province's economic regions. The major objective is to determine whether it is possible to make operational for government policy implementation the concept of program choice.

It is invariably assumed that there is a general need for increased government expenditures because of the existence of widespread unemployment and industrial excess capacity. However, a general increase in expenditures is likely not to be sensitive to regional differences in these variables. Raising the level of aggregate demand may accentuate the problem of regional unemployment because of differences in locational and industrial patterns of unemployment and excess capacity.[1] If the increased government spending is concentrated in industries and locations which are operating at or near full capacity rather than those where there is slack, the increased spending may be inflationary and may have limited employment-generating potential.

A brief overview of some regional characteristics of the Ontario economy in 1965 is presented here to set the stage for assessing the economic consequences of varying

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[1]Implicit in this proposition is the assumption that regional labour markets do not adjust efficiently and smoothly to changes in the regional pattern of labour demand.

the program mix of the provincial government expenditure budget.

In terms of regional industrial structures, there appears to be considerable variation in the degree of diversification among the regions, with the "central core" lying midway between the extremes. Here, the index of diversification, as presented in Table 1, is the percentage of mining and manufacturing income generated by the five largest industries. According to this index, the North-eastern and Northwestern regions are most specialized since about 95 and 90 percent, respectively, of their mining and manufacturing incomes accrue from the five leading industries. At the other extreme, Lake Erie region appears to be most diversified since its five leading industries account for only 37 percent of mining and manufacturing income.[2]

The composition and relative importance of these five leading industries varies from region to region. The Northeastern region is clearly "dominated" by mining, and the Northwestern region by pulp and paper production. To a lesser extent, regions such as St. Clair and Niagara may be regarded as "specialized" in motor vehicles industries, and iron and steel industries, respectively. And, finally, there are regions where specialization appears to be less obvious as in Central Ontario where the relative share of the leading industry, automobiles, is by no means dominant or suggestive of great specialization.

In sum, there are indications of significant differences among regions, in terms of both the composition and the degree of importance of their five leading industries. As a general principle, processing and later stages of manufacturing tend to be located in the "central core", particularly in the Central Ontario region, and

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[2]For greater detail, consult (Kubursi, et. al., Canadian Journal of Economics (February 1975)). pp. 67-92.

mining and initial stages of manufacturing industry tend to be located in the "outlying" regions. Under these circumstances, the central hypothesis of this study appears plausible -- viz., if each region has its own pattern of specialization, it should be possible to influence the growth of regional incomes and employment selectively by varying the program choice of government expenditures. Furthermore, given the diversified structure of Ontario and the physical proximity of each region to the rest, the general assumption underlying this analysis is credible -- viz., regardless of the location (and/or industry source) of demand, the sub-provincial supply pattern of a given industry's output is that of the province as a whole. If the sub-regions were distant from each other and had no apparent specialized industrial pattern, the goods and services required to support economic activity in a given sub-region would more likely be supplied from within that sub-region or from the nearest sub-regions. If this were the case in Ontario, the analysis would have required eleven intra-provincial, input-output sub-matrices.

Another distinctive characteristic of the sub-provincial economic structure of Ontario is the extent of regional income disparities within Ontario. The profile of these disparities in 1965 is also reported in Table 1. In that year, per capita income varied from a low of $1,546 in the Georgian Bay region to a high of $2,811 in Central Ontario. The two regions with highest per capita incomes, Central Ontario and Niagara, are often lumped together as the "Golden Horseshoe" or "central core" of the provincial economy. Ultimately it is the per capita income concept that stands as the test of regional income and employment effects of the various expenditure policy mixes. An attempt is made in this chapter to present results that correct income relatives by population relatives.

Table 1. Personal Income, Population and Industrial Concentration in Ontario Regions, 1965.

	Personal Income ($'000)	Personal Income Relatives	Population	Population Relatives	Mining and Manufacturing Income ($'000)	Mining and Manufacturing Relatives	Percentage of Income Generated by Largest Five Producer Groups.
1. Eastern Ont.	1,717,000	.105	850,923	.122	384,000	.051	.487
2. Lake Ont.	589,000	.036	350,903	.050	240,460	.032	.492
3. Central Ont.	7,032,000	.430	2,501,958	.360	3,033,984	.407	.470
4. Niagara	2,158,000	.132	840,181	.121	1,314,700	.176	.599
5. Lake Erie	916,000	.056	437,911	.063	346,350	.046	.373
6. St. Clair	1,112,000	.068	485,564	.071	649,410	.087	.751
7. Midwestern Ont.	916,000	.056	425,775	.061	457,474	.061	.423
8. Georgian Bay	507,000	.031	327,943	.047	123,093	.017	.476
9. Northeastern Ont.	965,000	.059	516,228	.074	708,525	.095	.946
10. Northwestern Ont.	441,000	.027	223,484	.032	200,047	.026	.894

Note: The five largest industries in descending order for each region are: (1) Eastern Ontario - synthetic textiles, other chemical industries, pulp and paper mills, printing and publishing, communications equipment; (2) Lake Ontario - other metal fabricating industries, electrical industrial equipment, other food industries, communications equipment, clay, lime and cement; (3) Central Ontario - motor vehicle and aircraft, other metal fabricating industries, printing and publishing, miscellaneous manufacturing, miscellaneous machinery; (4) Niagara - iron and steel, motor vehicles and aircraft, other metal fabricating industries, other chemical industries, miscellaneous machinery; (5) Lake Erie - other metal fabricating industries, communications equipment, motor vehicles and aircraft, rubber products, distilleries, breweries and wineries; (6) St. Clair - motor vehicles and aircraft, other chemical industries, distilleries, breweries, and wineries, other metal fabricating industries, other food industries; (7) Midwestern Ontario - other metal fabricating industries, rubber products, other textile mills, motor vehicles and aircraft, communications equipment; (8) Georgian Bay - other metal fabricating industries, furniture and fixtures, electrical appliances, other transportation equipment, other wood industries; (9) Northeastern Ontario - mining, iron and steel, pulp and paper mills, other primary metals, sawmills; (10) Northwestern Ontario - pulp and paper mills, mining, motor vehicles and aircraft, other food industries, other wood industries.

Source: Provincial and Regional Accounts Section, Economic Research, Ontario Ministry of Treasury, Economics, and Intergovernmental Affairs.

2. The Analytical Approach

(a) The Assumptions of the Model

The model applied here rests on a number of assumptions that qualify and restrict its applicability. These assumptions are independent of the assumptions made to construct the data needed to implement it, although some of the latter assumptions are indistinguishable from those pertaining to the model. The following is a short list of some of the crucial assumptions.

(i) The supply of labour is perfectly elastic at the prevailing equilibrium wage rates and employment is demand determined.

(ii) The supply of output is perfectly elastic at the prevailing equilibrium prices. Output is, therefore, assumed to be demand determined.

(iii) Exports and investment are exogenously determined and do not respond to changes in other variables of the model.

(iv) All variables are expressed in real terms and since prices do not change, all changes in the variables are quantity changes.

(v) Consumption is a linear function of disposable income and independent of relative prices. This in other words assumes that individuals possess Cobb-Douglas identical utility functions. It is also consistent with the assumption that each sub-region consumes a fixed proportion from each commodity.

(vi) The sub-regions of the province are assumed to be too close to each other and sufficiently specialized such that no interregional input-output system is required to analyze the sub-regional income and employment multipliers.

(vii) No substitution among factors of production is permitted.

(viii) The system is static.

(ix) Industrial purchases associated with each government expenditure program are invariant with the level of expenditures. In other words they represent fixed proportions.

(b) The Computation of Regional Income and Employment Multipliers

In what follows an attempt will be made to verbalize complex mathematical manipulations. Readers familiar with mathematics should consult the Technical Appendix instead.

The multiplier concept adopted here is the ordinary one which measures the sum of a series of income generations associated with the different rounds of interaction among the various sectors of the economy triggered by a unit change in final demand. The income components that are accumulated pertain to the initial income component under final demand and the weighted direct income associated with each industry sustaining the dollar increase in expenditures. To this is added the indirect income generated as the system of equations representing the input-output relationships of the economy are solved. In addition to all this, another component of income is added which reflects the endogeneity of consumption.

The computations are most easily visualized as being performed in two successive rounds. The first round consists of a conventional input-output calculation to determine the direct, indirect and induced output effects resulting from a change in a given government expenditure program. In the second round, the output effects are converted into income effects, and simultaneously allocated over the ten economic regions using the data on the regional distribution of sectoral value added and wages.

3. Difficulties with the Approach

It should be emphasized that economic models are primarily tools of planning and decision making. They do not replace the process of decision making but merely assist it. The model presented here suffers from the same limitations as all other models. It does not take account of all conceivable influences on the real-world systems to which it relates. It is ultimately a facsimile of reality. But this facsimile is a powerful construction that can explore idealized alternatives which could not be investigated in reality. It can be used for prediction, usually in a hypothetical and conditional form: if you do this, then that will follow, or if you want that to happen, then you must do this. Naturally, the results are not always precise and can only be viewed in the light of the assumptions made.

The assumptions made to operationalize our model impute a large measure of difficulties that should best be evaluated before implementing the model.

The assumptions about excess capacities, technology and fixities of prices and wages are all statements about initial conditions. If these are violated even in part, the conclusions and predictions of the model would have to be viewed with caution and suspicion. Furthermore, if the structure of production of the various regions is thought to be less specialized and transport costs among the various sub-regions of Ontario are considered significant, then the whole approach utilized here would have to be replaced with another that allows close sub-regions to trade more substantially with each other than is currently the case under this type of model.

The static nature of the model with investment taken as fixed will generate impact effects that are often temporary and fall short of the total effects.

Finally, we would like to emphasize that despite all these problems, our model does have a great advantage given its ability to provide quantitative estimates in place of general impressions about the spatial effects of fiscal policy in Ontario, and to take account of repercussions and interactions among different elements of a complex system.

4. The Results

Tables 2 and 3 report the results derived from applying the model developed in the Mathematical Appendix to the data on the interregional distribution of total income per ten thousand dollars increase in each provincial government expenditure program.

Table 2 presents estimates of total income (value added) generated by each program in every sub-region, where total income is calculated first as including only direct plus indirect effects, and then as including direct, indirect, and induced income effects. Each cell in the Table corresponds to a region, indicated by a column title. There are three entries in each cell. The first represents the total amount of income generated by direct and indirect effects in the region in response to a ten thousand dollars change in the program expenditure indicated by the row title. The second entry represents the total income generated in the region when induced effects are added to the direct and indirect effects. These two entries are, of course, interpreted as the regional total income effects associated with the given government expenditure program. The third entry in the cell has two numbers in parentheses, the first being the rank of the region with respect to income of the given program, and the second being the rank of the program within the given region. The lower is the first number, the greater the amount of total (direct, indirect and induced) income generated in that region by the program indicated in the row title as compared with income generated by that program in the other regions. The second number indicates which program generates the most total income for a given region: the lower this number, the greater the amount of total income generated in the given region by the particular program compared with all other programs.

Table 3 is constructed along lines similar to those underlying Table 2, with the exception that the data and ranks appearing in the cells relate to estimates of wage value added by region. Again, the first two entries in each cell are interpreted as regional wage income effects.

Since these tables are so detailed, the discussion below is confined to some of their more interesting and extreme features. The tables constructed for the actual expenditures of government will be modelled along similar lines. In fact, any discrepancy between the results reported in Tables 2 and 3 and those to follow reflects the fact that the unrestricted results in Tables 2 and 3 are independent of the actual expenditure weights. Given equal expenditures, some programs generate larger income in some regions than others. Thus, these income effects and/or multipliers can be utilized as indicators of the comparative productivity of expenditures.

(a) Regional Total Income Effects and Multipliers by Program

When the expenditure on a particular program is increased by ten thousand dollars, the regional income effects described in Table 2 indicate both the amount by which provincial income will increase in response to the initial increase in demand and, more importantly, the amounts in which this increased total income will be distributed inter-regionally.

One possibility is, of course, that the increased provincial income will be distributed among the regions according to the ranking of total incomes established in Table 1. However, the results described in Table 2 indicate that an increase in expenditures on a given program does not have a "neutral" expansionary effect on regional incomes, since in none of the program rows are inter-regional income effects rankings in exact correspondence with the inter-regional ranking of size.

In general, then, expansion in any particular program has differential impact on regional income distribution. This finding is suggestive of the possibility of selectivity in regional fiscal policy. Table 2 describes the extent of dispersion among regions in incomes generated in response to an increase of ten thousand dollars in a given expenditure program. Generally, the results indicate whether the increase in demand for the various expenditure programs has selective impact regionally, that is, whether the income effects are localized within a particular region or tend to spill over to other regions in the economy in proportion to their size.

Those programs which generate the greatest income expansion in each region (taking account of only direct, indirect and induced repercussions on regional income) can be singled out for comment. For instance, the General Government program has the greatest effect in Eastern Ontario, Central Ontario and Georgian Bay. Transportation and Communication has the greatest income effects in the Lake Ontario, Niagara, Lake Erie, Lake St. Clair, Midwestern Ontario and Northeastern Ontario regions. Interestingly, Recreation and Culture generates the largest income effects in Northwestern Ontario. An expansion in the Education program seems to generate rather limited income potential in most of the regions: it ranks seventh out of nine in four regions and eighth in the remaining regions. Similarly, expenditures on Health seem to generate low income effects in several regions: Health ranks eighth in Northwestern Ontario and sixth in Northeastern, Midwestern Ontario,

TABLE 2: DIFFERENTIAL INCOME IMPACT, PROGRAM BY REGION IN ONTARIO

	Eastern Ontario	Lake Ontario	Central Ontario	Niagara	Lake Erie	Lake St. Clair	Mid-Western Ontario	Georgian Bay	North Eastern Ontario	North Western Ontario
Education	221	83	871	241	124	132	119	78	121	58
	293	112	1150	327	169	187	164	106	161	77
	(3.7)	(8.7)	(1.7)	(2.8)	(5.8)	(4.8)	(7.8)	(9.8)	(6.8)	(10.7)
Transportation and Communication	433	197	1876	642	287	284	287	157	305	99
	593	262	2499	832	388	405	389	218	394	140
	(3.2)	(8.1)	(1.2)	(2.1)	(5.1)	(7.1)	(6.1)	(9.3)	(4.1)	(10.3)
Health	247	98	963	295	161	177	159	98	137	55
	330	132	1287	394	213	240	211	129	183	76
	(3.5)	(8.6)	(1.5)	(2.5)	(5.6)	(4.5)	(6.6)	(9.6)	(7.6)	(10.8)
Social and Economic Welfare	225	101	829	269	165	174	170	103	137	61
	302	132	1130	361	214	232	219	132	180	81
	(3.6)	(9.5)	(1.8)	(2.6)	(6.5)	(4.6)	(5.5)	(8.5)	(7.7)	(10.6)
Recreation and Culture	430	167	1578	474	245	250	234	162	271	112
	567	223	2114	638	332	355	321	215	348	147
	(3.3)	(8.3)	(1.3)	(2.3)	(6.3)	(5.3)	(7.3)	(9.2)	(4.2)	(10.1)
Home and Community	357	127	1379	364	189	199	179	123	188	94
	469	173	1816	498	260	284	250	165	250	123
	(3.4)	(8.4)	(1.4)	(2.4)	(5.4)	(4.4)	(7.4)	(9.4)	(6.4)	(10.4)
Industrial Develop. and Resources	221	81	956	254	127	147	125	79	140	65
	297	112	1254	345	176	205	173	108	182	84
	(3.8)	(8.8)	(1.6)	(2.7)	(6.7)	(4.7)	(7.7)	(9.7)	(5.5)	(10.5)
General Government	477	182	1963	566	277	283	281	172	269	100
	637	247	2587	757	378	405	383	233	358	141
	(3.1)	(8.2)	(1.1)	(2.2)	(6.2)	(4.2)	(5.2)	(9.1)	(7.3)	(10.2)
Public Safety Protection	118	44	563	162	66	93	65	39	66	31
	161	62	730	213	93	126	92	55	90	42
	(3.9)	(8.9)	(1.9)	(2.9)	(5.9)	(4.9)	(7.9)	(9.9)	(6.9)	(10.9)

Georgian Bay, Lake Erie and Lake Ontario, and fifth in Central Ontario, Niagara, and Lake St. Clair regions.

In general, it is possible to find references in Table 2 to programs which have primary impact in one of the regions of the "central core" and secondary impacts outside the "central core". But there is no program that has an impact in any single region outside the "central core" which is greater than its impact on one or the other of the "central core" regions. The pattern of income creation seems to be well defined. The Central Ontario region is first, Niagara is second, Eastern Ontario is third; the Northwestern region invariably ranks lowest for each and every program.

Differential regional effects tend to be apparent only for Lake Erie, Lake St. Clair, Midwestern Ontario, and Northeastern Ontario. However, in these regions there appears to be no dominant program and, hence, no obvious way to generate regional income growth without simultaneous, large, spillover effects in the "central core". There is, perhaps, the possibility of reducing relative disparities among these regions themselves, and between them and the "central core". The differences in income effects between each region and the "central core" by program are not equal, which suggests that by a careful and selective process a set of programs may be organized that can reduce relative income disparities. The empirical nature of this selectivity will be taken up later when actual program choice is examined.

(b) Regional Wage Income Effects and Multipliers

A large percentage of Ontario's industries are foreign-owned and, consequently, repatriate substantial income to non-residents of Ontario. Given government's interest in the capacity of its expenditure programs to generate employment in the various regions, Table 3 has been constructed. It reports the inter-regional distribution of increases in wage income.

A direct comparison of row and column rankings in Table 4 with row and column rankings in Table 2 relates the effects of program expansion on the inter-regional distribution of wage income to the effects on total income. The conclusions for wage income effects are essentially similar to the results already described in connection with Table 2. Programs which generate the large wage income effects in a particular region are usually those which also have the greatest effect on total income, although there are a few changes in ranking and relative magnitudes. The regional wage income distribution seems even more heavily clustered in the richer regions of Ontario than is total income. The possibility of generating employment opportunities in the outlying regions is constrained by this pattern of distribution. Changing the mix of program choice is of limited consequence when it comes to altering the regional employment profile. The "central core" is decisively dominant over the other regions in absolute as well as in relative wage income. For instance, the share of the "central core" in direct and indirect income for the Education and Transportation program is over 57 percent, whereas it is 56 percent for Health. It is 96 percent for General Government.

(c) Actual Government Expenditures by Program 1965/66-1972/73

The nature, pattern and magnitudes of growth in total government expenditures and the program composition of these expenditures over the period 1965/66-1972/73 are the subject of this section. Tables 3, 4 and 5 present the wages and salaries components, other expenditures (non-salary expenditures), and total expenditures by program, respectively.

The results indicate that expenditures on Education, Transportation and Communication, and Health accounted for almost 2/3 of total government expenditures between 1965/66 and 1969/70. This ratio increased from 65 percent in 1970/71 to 73 percent in 1971/72. The rise in this ratio from 1969/70 to 1971/72 is explained for the most part by the

TABLE 3: DIFFERENTIAL EMPLOYMENT IMPACT, PROGRAM BY REGION IN ONTARIO

	Eastern Ontario	Lake Ontario	Central Ontario	Niagara	Lake Erie	Lake St. Clair	Mid-Western Ontario	Georgian Bay	North Eastern Ontario	North Western Ontario
Education	93	33	416	104	52	54	49	31	48	22
	123	45	543	143	71	77	69	42	64	30
	(3.7)	(8.8)	(1.7)	(2.8)	(5.8)	(4.8)	(6.8)	(9.8)	(7.8)	(10.7)
Transportation and Communication	237	100	1064	338	149	156	156	85	147	48
	304	126	1348	423	190	206	200	109	183	64
	(3.2)	(8.1)	(1.2)	(2.1)	(6.2)	(4.2)	(5.2)	(9.2)	(7.1)	(10.2)
Health	127	48	537	152	77	87	80	46	65	24
	161	61	684	196	98	113	102	59	84	33
	(3.5)	(8.4)	(1.5)	(2.4)	(6.5)	(4.4)	(5.4)	(9.5)	(7.5)	(10.6)
Social and Economic Welfare	86	36	370	112	58	64	67	34	51	21
	118	49	507	153	78	88	89	46	69	29
	(3.8)	(8.6)	(1.8)	(2.7)	(6.7)	(5.7)	(4.6)	(9.6)	(7.7)	(10.8)
Recreation and Culture	183	68	722	205	106	106	102	69	117	46
	240	91	966	278	141	150	140	90	148	60
	(3.3)	(9.3)	(1.3)	(2.3)	(5.3)	(6.3)	(7.3)	(8.3)	(4.3)	(10.3)
Home and Community	144	48	638	147	78	78	71	47	71	35
	191	67	837	207	107	113	102	65	96	46
	(3.4)	(8.5)	(1.4)	(2.5)	(4.4)	(5.5)	(6.5)	(9.4)	(7.4)	(10.4)
Industrial Develop. and Resources	102	35	505	121	59	65	57	34	60	27
	134	48	641	162	78	90	78	46	77	34
	(3.6)	(8.7)	(1.6)	(2.6)	(6.6)	(4.6)	(7.7)	(9.7)	(5.6)	(10.5)
General Government	270	99	1165	313	155	160	162	96	143	50
	337	125	1449	398	196	210	207	121	179	66
	(3.1)	(8.2)	(1.1)	(2.2)	(6.1)	(5.1)	(4.1)	(9.1)	(7.2)	(10.1)
Public Safety Protection	58	21	293	81	33	46	31	18	30	13
	76	28	370	104	44	59	43	25	40	18
	(3.9)	(8.9)	(1.9)	(2.9)	(5.9)	(4.9)	(6.9)	(9.9)	(7.9)	(10.9)

TABLE 3: EXPENDITURE BY GOVERNMENT PROGRAM (WAGES AND SALARIES)

	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72
Education	24348(9%)	27624(9%)	51708(14%)	55463(13%)	37035(7%)	133868(14%)	160279(9%)
Transportation and Communication	62195(23%)	68104(21%)	69681(19%)	78842(18%)	80581(16%)	83120(8%)	80048(5%)
Health	66778(25%)	76743(24%)	71112(19%)	92715(21%)	130913(26%)	460230(47%)	1079684(64%)
Social Welfare	4999(2%)	6176(2%)	8043(2%)	9842(2%)	11553(2%)	19739(2%)	33402(2%)
Recreation and Cultural Services	3264(1%)	4425(1%)	4194(1%)	5273(1%)	9579(2%)	16506(2%)	16183(1%)
Nat.Resources,Trade, Ind.Devel.,Govt.Dev.	37083(14%)	45313(14%)	52232(14%)	65177(15%)	76545(15%)	37056(4%)	48262(3%)
General Government Services	21721(8%)	26076(8%)	29104(8%)	36606(8%)	38668(8%)	76463(8%)	92456(5%)
Protection Persons and Property	47468(18%)	62315(20%)	76065(21%)	97120(22%)	114868(23%)	157718(16%)	177892(11%)
Grand Total	269160	318903	365173	441191	499824	984700*	1688206*

* This is total of programs 1-8 listed above.

Source: D.B.S. Provincial Government Finance, Catalogue No. 68-207, 1965-1973.

TABLE 4: EXPENDITURE BY GOVERNMENT PROGRAM (OTHER EXPENDITURES)

	1965	1966	1967	1968	1969	1970	1971
Education	22881(7%)	58076(10%)	37545(7%)	112134(16%)	140466(16%)	56882(7%)	68104(5%)
Transportation and Communication	169551(50%)	212444(37%)	220881(40%)	239438(35%)	232072(27%)	231253(28%)	222704(18%)
Health	44514(13%)	61670(11%)	139895(26%)	158777(23%)	289114(33%)	279928(34%)	656701(53%)
Social Welfare	4750(1%)	6265(1%)	16603(3%)	10706(2%)	2193(0%)	12383(2%)	20955(2%)
Recreation and Cultural Services	1404(0%)	4625(1%)	10704(2%)	7853(1%)	17878(2%)	22194(3%)	21760(2%)
Nat.Resources,Trade, Ind.Devel.Govt.Dev.	28371(8%)	35909(6%)	38773(7%)	47973(7%)	46948(5%)	22453(3%)	29243(2%)
General Government Services	33642(10%)	47602(8%)	47180(9%)	52277(8%)	53566(6%)	145554(18%)	175999(14%)
Protection Persons and Property	29220(9%)	27656(5%)	30572(6%)	52522(8%)	58630(7%)	43069(5%)	48578(4%)
Grand Total	336697	577895	546124	688323	863182	813716*	1244044*

* This is total of programs 1-8 listed above.

Source: D.B.S. Provincial Government Finance, Catalogue No. 68-207, 1965-1973.

TABLE 5: EXPENDITURE BY GOVERNMENT PROGRAM (TOTAL EXPENDITURE)

	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72	1972/73
Education	47229(8%)	85700(10%)	89253(10%)	167597(15%)	177501(13%)	190750(10%)	228383(7%)	223839(7%)
Transportation and Communication	231746(38%)	280548(31%)	290562(32%)	318280(28%)	312653(23%)	314373(16%)	302752(10%)	311817(9%)
Health	111292(18%)	138413(15%)	211007(23%)	251492(22%)	420027(31%)	740158(39%)	1736385(56%)	1968493(58%)
Social Welfare	9749(2%)	12441(1%)	24646(3%)	20548(2%)	13746(1%)	32122(2%)	54357(2%)	47283(14%)
Recreation and Cultural Services	4668(1%)	9050(1%)	14898(2%)	13126(1%)	27457(2%)	38700(2%)	37943(1%)	29495(1%)
Nat.Resources,Trade, Ind.Devel.Govt.Dev.	65454(11%)	81222(9%)	91005(10%)	113150(10%)	123493(9%)	59509(3%)	77505(3%)	144869(4.24%)
General Government Services	55363(9%)	73678(8%)	76284(8%)	88883(8%)	92234(7%)	222017(12%)	268455(9%)	258846(7.58%)
Protection Persons and Property	76688(13%)	89971(10%)	106637(12%)	149642(13%)	173498(13%)	200787(10%)	226470(7%)	249376(7.31%)
Grand Total	605857	896798	911297	1129514	1363006	1917954	3075915	3412050

rise in expenditures on Health which increased more than fifteen-fold between 1965/66 and 1971/72 from $111 million to $1,736 million.

Total expenditures increased almost five-fold between 1965/66 and 1971/72. Expenditures on Education also increased five-fold, whereas expenditures on Transportation and Communications increased by only thirty percent, and expenditures on Natural Resources, and Industrial Development by a meager eighteen percent. Interestingly, expenditures on Recreation and Cultural Services increased more than eight times.

Expenditures on Health in 1972/73 account for almost 58 percent of total government expenditure. This fact and the other changes discussed above have far reaching consequences for the distribution and generation of income in the various sub-regions of the province. The discussion of these impacts are the subject matter of the next section.

(d) Differential Regional Impacts of Government Expenditure Programs in 1965/66

The ten regions were ranked in descending order according to population relatives in Table 1 as follows: Central Ontario, Eastern Ontario, Niagara, Northeastern Ontario, St. Clair, Lake Erie, Midwestern Ontario, Lake Ontario, Georgian Bay and Northwestern Ontario. The results in Table 6 show that there is a discrepancy between the way increased provincial income resulting from provincial government expenditures in 1965/66 was distributed over the regions and regional population relatives. In Table 7, the ratios of regional income generated by each program (excluding induced effects) are presented to demonstrate the extent of such discrepancies. If, for a given expenditure program, in a particular region the ratio is less than one, it simply indicates that the region is not receiving the share of income that its population relative would have qualified it to receive, and *vice versa* if the ratio is greater than one. When the ratio is equal to one, the impact is judged to be neutral. The tables in which these ratios are presented are extensions of the preceding tables, but answer different questions. The ratios are particularly relevant since they indicate whether each region partakes sufficiently, given its population, in the general growth of the province. On the other hand, the absolute income figures are particularly suited for questions pertaining to the actual magnitude of economic policies.

Several interesting remarks can be made about the results in Table 7. The various expenditure programs seem to have generated marked differences in their regional impact in 1965. For instance, expenditures on Education have generated a disproportionate impact in Central Ontario; in no other region did this program generate an income relative that exceeded the population relative. Transportation and Communications also seem to have favoured the "central core". Health, on the other hand, generated ratios greater than one in the "central core", but also in Lake Erie, Lake St. Clair, and Midwestern Ontario. Given the large share of the Health program in total provincial expenditures, it is probable that Health expenditures had an ameliorative influence on regional per capita income disparities in Ontario in 1965/66.

Nevertheless, it is disturbing to find that, in 1965/66, regardless of the expenditure program, Eastern Ontario did not have a single ratio greater than one which indicates that this region did not share in the total income generated in the province in proportion to its population. If no emigration of people were to take place from this region, it would suffer a loss in relative per capita income. It is worth noting that the Industrial Development and Resources Program came close to generating a neutral impact in this region. In Northwestern Ontario all programs except Industrial Development and Resources generated what may be considered destabilizing impacts; the most depressing impact (ratio less than one) was generated surprisingly by the Transportation and Communications program. In Northeastern Ontario, only Industrial Development and Resources generated a per capita income relative greater than one. In Georgian Bay none of the programs had any ameliorative impact; in fact, all served to increase regional per capita disparities. Lake Ontario region benefited relatively from none of the programs.

On the other hand, the differential per capita income impacts of almost all programs except Education and Recreation and Culture had positive influences on Midwestern Ontario. This region had a share of total income generated by these programs that exceeded its population share. In Lake St. Clair a number of programs had impacts that exceeded one. These were Public Safety and Protection, Industrial Development and Resources, Social and Economic Welfare, and Health. The remaining programs had ratios less than one. Lake Erie region benefitted from expenditures on Health, Social and Economic Welfare, Industrial Development and Resources, General Government, and Public Safety and Protection. Niagara region benefitted from almost every expenditure program save Education. Similarly, Central Ontario benefitted rather markedly from most programs with the exception of Public Safety and Protection and Industrial Development and Resources.

The general conclusion is clear. Some expenditure programs seem to have generated impacts in outlying regions that exceed their population relatives. However, the most depressed regions of Ontario were adversely affected by the pattern of program choice by the provincial government. A notable exception is the positive differential income effects generated by the very large Health expenditure program.

When they are considered, the macroeconomic effects of consumption have a decisive impact. For example, the

Central Ontario region now shows ratios greater than one for every program. Furthermore, these ratios are larger than any corresponding row entry in Table 8. This suggests that while it was possible to expand one of the outlying regions relative to the other outlying regions, it was not generally possible to expand those regions relative to the "central core". Five regions show no program with income relatives greater than their population relatives. The inclusion of final demand weights reinforces the concentration of the province's growth in the "central core" which was apparent earlier. Efforts to eliminate regional disparities, therefore, may be to some extent self-defeating.

The analysis of wage income ratios reveals the concentration of the highest levels of per capita wage income relatives in Central Ontario. Niagara and Midwestern Ontario feature a number of ratios that exceed one. In fact, for the Social and Economic Welfare program in Midwestern Ontario the ratio exceeds the corresponding entry in Central Ontario. The inclusion of induced effects alters the pattern in much the same way as its inclusion altered the income relatives in Table 8.

The indices in Table 10 indicate a greater tendency towards clustering of wage income relatives in Central Ontario. In Niagara, Midwestern Ontario, Lake St. Clair and Lake Erie, there exists no program with a ratio exceeding one.

The differential wage income effects, by program and region, for the 1965/66 provincial government expenditure pattern are presented in Table 11. The results are rather similar to those in Table 6; however, some rankings have changed and the relative effects are more clustered.

TABLE 6: DIFFERENTIAL INCOME IMPACT, PROGRAM BY REGION IN ONTARIO 1965/66

	Eastern Ontario	Lake Ontario	Central Ontario	Niagara	Lake Erie	Lake St. Clair	Mid-Western Ontario	Georgian Bay	North Eastern Ontario	North Western Ontario
Education	3133	1171	12340	3422	1756	1877	1687	1109	1712	829
	3265	1248	12832	3648	1886	2085	1835	1178	1792	858
	(3.6)	(8.6)	(1.6)	(2.6)	(5.6)	(4.6)	(7.6)	(9.6)	(6.6)	(10.6)
Transportation and Communication	13243	6012	57358	19621	8771	8674	8779	4795	9326	3023
	16073	7102	67774	22576	10510	10986	10537	5910	10680	3797
	(3.1)	(8.1)	(1.1)	(2.1)	(6.1)	(7.1)	(5.1)	(9.1)	(4.1)	(10.1)
Health	8001	3189	31212	9549	5209	5728	5144	3161	4443	1773
	8360	3354	32620	9981	5400	6079	5359	3277	4644	1927
	(3.2)	(8.2)	(1.2)	(2.2)	(5.2)	(4.2)	(6.2)	(9.2)	(7.2)	(10.2)
Social and Economic Welfare	611	274	2249	730	449	471	461	278	372	166
	650	285	2429	776	460	499	471	284	387	174
	(3.7)	(9.7)	(1.7)	(2.7)	(6.7)	(4.7)	(5.7)	(8.7)	(7.7)	(10.7)
Recreation and Culture	418	162	1535	460	238	244	228	158	264	109
	431	170	1609	485	253	270	245	163	264	112
	(3.8)	(8.8)	(1.8)	(2.8)	(6.8)	(5.8)	(7.8)	(9.8)	(4.8)	(10.8)
Industrial Develop. and Resources	5141	1885	13395	5910	2967	3425	2910	1831	3257	1507
	4593	1734	19396	5334	2714	3172	2682	1668	2819	1304
	(3.4)	(8.4)	(1.4)	(2.4)	(6.4)	(4.4)	(7.4)	(9.4)	(5.4)	(10.4)
General Government	4098	1562	13267	4869	2385	2434	2416	1479	2316	862
	4398	1707	17873	5233	2614	2797	2644	1612	2476	977
	(3.5)	(8.5)	(1.5)	(2.5)	(6.5)	(4.5)	(5.5)	(9.5)	(7.5)	(10.5)
Public Safety Protection	5814	2166	16846	7940	3261	4585	3174	1904	3266	1509
	5068	1937	22966	6691	2937	3959	2887	1735	2840	1312
	(3.3)	(8.3)	(1.3)	(2.3)	(6.3)	(4.3)	(7.3)	(9.3)	(5.3)	(10.3)
Region Total	40459	16421	148202	52501	25036	27438	24799	14715	24956	9780
	42838	17537	177499	54724	26774	29847	26660	15827	25902	10461

TABLE 7: RATIOS OF INCOME RELATIVES TO POPULATION RELATIVES, BY PROGRAM AND REGION, ONTARIO, 1965/66

(No Induced Effects)

	Eastern Ontario	Lake Ontario	Central Ontario	Niagara	Lake Erie	Lake St. Clair	Mid-Western Ontario	Georgian Bay	North Eastern Ontario	North Western Ontario
Education	.8846	.8066	1.1806	.9740	.9598	.9106	.9526	.8123	.7966	.8919
Transportation and Communication	.7775	.8613	1.1413	1.1616	.9973	.8751	1.0309	.7308	.9028	.6771
Health	.8472	.8240	1.1200	1.0195	1.0681	1.0421	1.0895	.8687	.7756	.7157
Social and Economic Welfare	.8268	.9039	1.0308	.9948	1.1750	1.0945	1.2470	.9765	.8298	.8553
Recreation and Culture	.8974	.8505	1.1174	.9974	.9921	.8991	.9788	.8790	.9341	.8920
Industrial Develop. and Resources	.9978	.8929	.8811	1.1567	1.1153	1.1424	1.1296	.9226	1.0423	1.1150
General Government	.9412	.8755	1.0326	1.1274	1.0608	.9606	1.1096	.8819	.8770	.7552
Public Safety Protection	.9443	.8584	.9272	1.3003	1.0256	1.2797	1.0311	.8029	.8746	.9345

TABLE 8: RATIOS OF INCOME RELATIVES TO POPULATION RELATIVES, BY PROGRAM AND REGION, ONTARIO, 1965/66

(Induced Effects Included)

	Eastern Ontario	Lake Ontario	Central Ontario	Niagara	Lake Erie	Lake St. Clair	Mid-Western Ontario	Georgian Bay	North Eastern Ontario	North Western Ontario
Education	.8738	.8151	1.1638	.9844	.9773	.9589	.9824	.8186	.7905	.8753
Transportation and Communication	.7939	.8560	1.1345	1.1243	1.0053	.9324	1.0409	.7578	.8697	.7150
Health	.8460	.8281	1.1186	1.0183	1.0582	1.0570	1.0847	.8608	.7748	.7436
Social and Economic Welfare	.8307	.8880	1.0518	.9998	1.1384	1.0962	1.2028	.9415	.8155	.8480
Recreation and Culture	.8834	.8479	1.1167	1.0018	1.0014	.9504	1.0021	.8684	.8931	.8753
Industrial Develop. and Resources	.8229	.7637	1.1863	.9707	.9487	.9837	.9680	.7812	.8388	.8973
General Government	.8516	.8067	1.1728	1.0217	.9801	.9305	1.0238	.8102	.7905	.7215
Public Safety Protection	.7938	.7403	1.2191	1.0566	.8907	1.0656	.9045	.7052	.7333	.7837

TABLE 9: RATIOS OF WAGE INCOME RELATIVES TO POPULATION RELATIVES, BY PROGRAM AND REGION, ONTARIO, 1965/66

(No Induced Effects)

	Eastern Ontario	Lake Ontario	Central Ontario	Niagara	Lake Erie	Lake St. Clair	Mid-Western Ontario	Georgian Bay	North Eastern Ontario	North Western Ontario
Education	.8407	.7372	1.2789	.9563	.9173	.8465	.8978	.7294	.7118	.7761
Transportation and Communication	.7836	.8045	1.1919	1.1273	.9558	.8837	1.0302	.7281	.8019	.6044
Health	.8359	.7647	1.1999	1.0110	.9838	.9839	1.0500	.7942	.7120	.6121
Social and Economic Welfare	.7850	.8057	1.1411	1.0278	1.0300	.9961	1.2272	.8077	.7672	.7367
Recreation and Culture	.8689	.7927	1.1642	.9813	.9730	.8688	.9724	.8492	.9151	.8310
Industrial Develop. and Resources	.7864	.6630	1.3151	.9401	.8747	.8651	.8802	.6861	.7600	.7814
General Government	.8482	.7562	1.2386	.9895	.9420	.8606	1.0189	.7838	.7379	.5955
Public Safety Protection	.7564	.6746	1.3054	1.0671	.8298	1.0326	.8220	.6164	.6584	.6718

TABLE 10: RATIOS OF WAGE INCOME RELATIVES TO POPULATION RELATIVES, BY PROGRAM AND REGION, ONTARIO, 1965/66

(Induced Effects Included)

	Eastern Ontario	Lake Ontario	Central Ontario	Niagara	Lake Erie	Lake St. Clair	Mid-Western Ontario	Georgian Bay	North Eastern Ontario	North Western Ontario
Education	.8339	.7474	1.2512	.9784	.9303	.8985	.9410	.7390	.7145	.7710
Transportation and Communication	.7900	.7989	1.1868	1.1096	.9586	.9202	1.0387	.7365	.7849	.6368
Health	.8309	.7676	1.1930	1.0184	.9806	.9993	1.0544	.7883	.7143	.6437
Social and Economic Welfare	.7925	.7983	1.1483	1.0323	1.0138	1.0115	1.1856	.7971	.7554	.7418
Recreation and Culture	.8549	.7890	1.1652	.9973	.9720	.9154	.9970	.8286	.8666	.8121
Industrial Develop. and Resources	.7926	.6898	1.2810	.9644	.8966	.9090	.9243	.7050	.7513	.7755
General Government	.8410	.7607	1.2241	1.0008	.9475	.9003	1.0294	.7804	.7347	.6285
Public Safety Protection	.7692	.6979	1.2745	1.0620	.8611	1.0375	.8779	.6504	.6729	.6908

TABLE 11: DIFFERENTIAL EMPLOYMENT IMPACT, PROGRAM BY REGION IN ONTARIO, 1965/66

	Eastern Ontario	Lake Ontario	Central Ontario	Niagara	Lake Erie	Lake St. Clair	Mid-Western Ontario	Georgian Bay	North Eastern Ontario	North Western Ontario
Education	2709	974	12162	3056	1527	1588	1447	906	1391	656
	2757	1013	12209	3209	1589	1729	1556	941	1433	669
	(3.6)	(8.6)	(1.6)	(2.6)	(5.6)	(4.6)	(6.6)	(9.6)	(7.6)	(10.5)
Transportation and Communication	9964	4193	44720	14217	6276	6540	6549	3566	6184	2016
	11148	4620	49420	15530	6985	7557	7329	4004	6718	2357
	(3.1)	(8.1)	(1.1)	(2.1)	(6.1)	(5.1)	(4.1)	(9.1)	(7.1)	(10.1)
Health	7374	2765	31235	8845	4482	5051	4631	2699	3810	1416
	7488	2835	31724	9103	4563	5241	4751	2737	3905	1522
	(3.2)	(8.2)	(1.2)	(2.2)	(6.2)	(4.2)	(5.2)	(9.2)	(7.2)	(10.2)
Social and Economic Welfare	520	219	2229	675	352	384	406	206	308	128
	540	223	2307	697	356	401	404	209	312	132
	(3.7)	(8.7)	(1.7)	(2.7)	(6.7)	(5.7)	(4.7)	(9.7)	(7.7)	(10.7)
Recreation and Culture	372	139	1469	416	215	216	208	140	237	93
	374	142	1505	433	220	233	218	140	230	93
	(3.8)	(9.8)	(1.8)	(2.8)	(6.8)	(5.8)	(7.8)	(8.8)	(4.8)	(10.8)
Industrial Develop. and Resources	3848	1330	18989	4563	2210	2463	2154	1293	2256	1003
	3967	1415	18919	4787	2317	2648	2313	1359	2281	1018
	(3.4)	(8.4)	(1.4)	(2.4)	(6.4)	(4.4)	(7.4)	(9.4)	(5.4)	(10.4)
General Government	3157	1154	13604	3653	1811	1864	1896	1124	1666	581
	3364	1247	14447	3970	1957	2096	2059	1203	1782	659
	(3.5)	(8.5)	(1.5)	(2.5)	(6.5)	(5.5)	(4.5)	(9.5)	(7.5)	(10.6)
Public Safety Protection	4549	1663	23165	6364	2577	3614	2472	1428	2402	1060
	4675	1738	22860	6402	2703	3670	2668	1523	2481	1101
	(3.3)	(8.3)	(1.3)	(2.3)	(5.3)	(4.3)	(6.3)	(9.3)	(7.3)	(10.3)
Region Total	32493	12437	147573	41789	19450	21720	19763	11362	18254	6953
	34313	13233	153391	44131	20690	23575	21298	12116	19142	7551

(e) Differential Regional Impact of Government Expenditures in 1972/73

The largest income contribution in each and every region is now made by Health. Even in Niagara, which as recently as 1969/70, had the largest income generated by Transportation and Communication, now features a contribution by the Health program which is almost six times as large as that made by Transportation and Communication. In some regions the Health contribution is almost ten times the second largest contribution. More interesting, however, is the fact that Health's contribution in many regions is larger or just as large as the sum of contributions generated by the rest of the programs combined.

The Education program makes its largest relative contributions in Eastern Ontario, Central Ontario and Northwestern Ontario. This represents an improvement over 1965/66 as well as over 1968/69 and 1969/70 when it ranked lower in the same regions. Public Safety and Protection is now credited with the second largest income contribution in every region in Ontario except in Central Ontario where it ranked fourth.

The decline in the relative and absolute income contribution of Transportation and Communication is clearly indicated from results presented in Table 12. In Eastern Ontario it now ranks fifth, third in Lake Ontario, second in Central Ontario, third in Niagara, Lake Erie, Lake St. Clair, Midwestern Ontario and Northeastern Ontario, fourth in Northwestern Ontario and fifth in Georgian Bay. Industrial Development and Resources seems to have also suffered a reduction in relative importance. Instead of the fourth rank it enjoyed in 1965/66, its rank in 1972/73 had slipped to sixth. General Government, on the other hand shows a minor improvement in most regions from the fifth rank to the fourth.

The differential employment incomes generated by each program in every region in 1972/73 are presented in Table 13. The results indicate again a clear dominance of Health, a general softening in the impact of Transportation and Communication, and a growing importance of Education. The magnitudes of absolute wage income are rather large and the inter-program differentials are wide. It is also clear that the inter-regional absolute differentials are widening.

To demonstrate the differential impact of changes in the relative importance of programs when no changes are made in their industrial composition, we generated the income contribution in 1972/73 of each program using the 1965/66 budget proportions. In other words we generated the income contribution of each program in 1972/73 as if the budget in 1972/73 is allocated over programs in just the same way as the 1965/66 budget was. The results of this hypothetical experiment are presented in Table 13 for the total income impact and in Table 14 for employment income.

Interestingly, Transportation and Communication assumes dominance over every other program; Health ranks second and Public Safety and Protection, third. Education is generally sixth and Industrial Development and Resources fourth. The inter-program differentials are rather small in marked contrast to 1972/73 proportions.

The total regional impact is also changed, Lake Ontario fares better under the 1965/66 proportions than under 1972/73 proportions and so does Niagara, Northeastern and Northwestern Ontario. In fact, every region shows an improvement, however small, over its total income share under 1972/73 proportions. This suggests that the budget proportions in 1972/73 generated lower income than they could have. For if the budget were allocated according to 1965 proportions, higher incomes would have resulted in nearly all the regions of the province. Since some outlying regions improved more

TABLE 12. DIFFERENTIAL INCOME IMPACT, PROGRAM BY REGION IN ONTARIO, 1972/73

	Eastern Ontario	Lake Ontario	Central Ontario	Niagara	Lake Erie	Lake St. Clair	Mid-Western Ontario	Georgian Bay	North Eastern Ontario	North Western Ontario
Education	18428	6887	72576	20125	10326	11040	9923	6520	10066	4874
	18699	7149	73491	20892	10800	11942	10512	6749	10261	4913
	(3.3)	(8.5)	(1.3)	(2.5)	(5.5)	(4.4)	(7.5)	(9.4)	(6.5)	(10.3)
Transportation and Communication	17754	8060	76899	26306	11759	11628	11770	6428	12504	4056
	21580	9536	90994	30310	14111	14750	14147	7935	14339	5098
	(3.5)	(8.3)	(1.2)	(2.3)	(6.3)	(7.3)	(5.3)	(9.5)	(4.3)	(10.4)
Social and Economic Welfare	3342	1497	12294	3988	2452	2575	2520	1520	2034	907
	3496	1531	13060	4173	2474	2685	2531	1526	2081	936
	(3.7)	(9.7)	(1.7)	(2.7)	(6.7)	(4.7)	(5.7)	(8.7)	(7.7)	(10.7)
Health	144894	57750	565219	172921	94331	103721	93162	57236	80451	32103
	150875	60529	588709	180126	97461	109713	96726	59141	83817	34785
	(3.1)	(8.1)	(1.1)	(2.1)	(5.1)	(4.1)	(6.1)	(9.1)	(7.1)	(10.1)
Recreation and Culture	2104	817	7731	2319	1201	1227	1147	794	1328	549
	2315	910	8633	2603	1355	1449	1313	876	1419	602
	(3.8)	(8.8)	(1.8)	(2.8)	(6.8)	(6.8)	(7.8)	(9.8)	(4.8)	(10.8)
Industrial Develop- and Resources	12188	4470	31759	14013	7035	8121	6899	4341	7723	3572
	10747	4058	45383	12481	6351	7422	6275	3902	6596	3051
	(3.6)	(8.6)	(1.6)	(2.6)	(6.6)	(4.6)	(7.6)	(9.6)	(5.6)	(10.6)
General Government	18326	6987	59332	21773	10666	10885	10803	6615	10358	3857
	20064	7789	81534	23874	11924	12758	12060	7353	11297	4459
	(3.4)	(8.4)	(1.5)	(2.4)	(6.4)	(4.5)	(5.4)	(9.3)	(7.4)	(10.5)
Public Safety Protection	23201	8643	87220	31684	13012	18296	12666	7599	13034	6022
	19831	7580	89873	26183	11492	15493	11299	6788	11112	5136
	(3.2)	(8.2)	(1.4)	(2.2)	(6.2)	(4.2)	(7.2)	(9.2)	(5.2)	(10.2)
Region Total	240237	95111	893030	293129	150782	167493	148890	91053	137498	55940
	247607	99082	991677	300642	155968	176212	154863	94270	140922	58980

TABLE 13. DIFFERENTIAL EMPLOYMENT IMPACT, PROGRAM BY REGION IN ONTARIO, 1972/73

	Eastern Ontario	Lake Ontario	Central Ontario	Niagara	Lake Erie	Lake St. Clair	Mid-Western Ontario	Georgian Bay	North Eastern Ontario	North Western Ontario
Education	16731 16799 (3.3)	6013 6171 (8.3)	75102 74381 (1.3)	18874 19550 (2.4)	9427 9678 (5.3)	9804 10535 (4.3)	8933 9479 (6.3)	5592 5736 (9.3)	8592 8731 (7.3)	4051 4074 (10.3)
Transportation and Communication	13317 14917 (3.5)	5604 6183 (8.4)	59771 66133 (1.4)	19002 20782 (2.4)	8388 9348 (6.4)	8741 10113 (5.4)	8754 9807 (4.4)	4767 5358 (9.5)	8266 8990 (7.4)	2694 3154 (10.4)
Health	134255 136103 (3.1)	50335 51531 (8.1)	568696 576605 (1.1)	161046 165443 (2.1)	81600 82943 (6.1)	91966 95263 (4.1)	84320 86357 (5.1)	49141 49746 (9.1)	69362 70971 (7.1)	25785 27656 (10.1)
Social and Economic Welfare	2940 3025 (3.7)	1237 1249 (8.7)	12610 12935 (1.7)	3817 3908 (2.7)	1992 1998 (6.7)	2171 2247 (5.7)	2298 2263 (4.7)	1165 1172 (9.7)	1743 1149 (7.7)	724 743 (10.7)
Recreation and Culture	1643 1718 (3.8)	614 650 (9.8)	6494 6911 (1.8)	1840 1988 (2.8)	950 1009 (6.8)	956 1071 (5.8)	919 1002 (7.8)	618 642 (8.8)	1049 1057 (4.8)	412 428 (10.8)
Industrial Develop. and Resources	9213 9457 (3.6)	3184 3373 (8.6)	45470 45103 (1.6)	10925 11413 (2.6)	5292 5524 (6.6)	5899 6312 (4.6)	5157 5515 ((7.6)	3097 3241 (9.6)	5401 5437 (5.6)	2401 2427 (10.6)
General Government	13813 14873 (3.4)	5047 5513 (8.5)	59519 63878 (1.5)	15982 17554 (2.5)	7921 8653 (6.5)	8156 9266 (5.5)	8296 9102 (4.5)	4917 5317 (9.4)	7288 7881 (7.5)	2544 2915 (10.5)
Public Safety Protection	18384 18786 (3.2)	6720 6985 (8.2)	93625 91855 (1.2)	25723 25725 (2.2)	10415 10861 (5.2)	14607 14746 (4.2)	9990 10720 (6.2)	5772 6120 (9.2)	9707 9968 (7.2)	4283 4425 (10.2)
Regional Total	210296 215678	78754 81655	921287 937801	257209 266363	125985 130014	142300 149553	128667 134245	75069 77332	111408 114784	42894 45822

TABLE 14. DIFFERENTIAL EMPLOYMENT IMPACT, PROGRAM BY REGION IN ONTARIO, 1972/73
Using 1965/66 Budget Proportions

	Eastern Ontario	Lake Ontario	Central Ontario	Niagara	Lake Erie	Lake St. Clair	Mid-Western Ontario	Georgian Bay	North Eastern Ontario	North Western Ontario
Education	18390 18524 (3.6)	6609 6805 (8.6)	82550 82020 (1.8)	20746 21558 (2.6)	10362 10672 (5.6)	10776 11617 (4.6)	9819 10452 (6.6)	6147 6325 (9.6)	9444 9628 (7.6)	4453 4493 (10.5)
Transportation and Communication	58008 62944 (3.1)	24409 26088 (8.1)	260355 279050 (1.1)	82770 87691 (2.1)	36536 39443 (6.1)	38073 42671 (5.1)	38130 41383 (4.1)	20764 22609 (9.1)	36005 37935 (7.1)	11735 13309 (10.1)
Health	50091 50433 (3.2)	18780 19095 (8.2)	212181 213663 (1.2)	60087 61305 (2.2)	30445 30735 (6.2)	34313 35300 (4.2)	31460 32000 (5.2)	18335 18433 (9.2)	25879 26299 (7.2)	9620 10248 (10.2)
Social and Economic Welfare	3527 3621 (3.7)	1483 1495 (8.7)	15128 15482 (1.7)	4580 4678 (2.7)	2390 2392 (6.7)	2604 2690 (5.7)	2757 2708 (4.7)	1398 1403 (9.7)	2091 2093 (7.7)	868 889 (10.7)
Recreation and Culture	2533 2526 (3.8)	947 956 (9.8)	10014 10161 (1.8)	2837 2923 (2.8)	1465 1483 (6.8)	1474 1574 (5.8)	1417 1473 (7.8)	954 943 (8.8)	1618 1553 (4.8)	635 629 (10.8)
Industrial Develop. and Resources	26150 26717 (3.4)	9037 9529 (8.4)	129053 127415 (1.4)	31008 32241 (2.4)	15020 15606 (6.4)	16742 17831 (4.4)	14636 15578 (7.4)	8790 9155 (9.4)	15329 15360 (5.4)	6816 6856 (10.4)
General Government	19462 20242 (3.5)	7111 7504 (8.5)	83859 86937 (1.5)	22518 23890 (2.5)	11161 11776 (6.5)	11491 12611 (5.5)	11689 12388 (4.5)	6928 7236 (9.5)	10269 10726 (7.5)	3584 3967 (10.6)
Public Safety Protection	31432 32166 (3.3)	11489 11960 (8.3)	160074 157273 (1.3)	43979 44047 (2.3)	17806 18595 (5.3)	24974 25248 (4.3)	17080 18355 (6.3)	9868 10479 (9.3)	16597 17068 (7.3)	7323 7577 (10.3)
Region Total	209593 217173	79865 83432	953214 972001	268525 278333	125185 130702	140447 149542	126988 134337	73184 76583	117232 120662	45034 47968

TABLE 15. DIFFERENTIAL INCOME IMPACT, PROGRAM BY REGION IN ONTARIO, 1972/73
Using 1965/66 Budget Proportions

	Eastern Ontario	Lake Ontario	Central Ontario	Niagara	Lake Erie	Lake St. Clair	Mid-Western Ontario	Georgian Bay	North Eastern Ontario	North Western Ontario
Education	20494	7659	80712	22382	11484	12278	11035	7250	1194	5420
	20932	8003	82266	23387	12090	13367	11767	7555	11486	5500
	(3.6)	(8.6)	(1.5)	(2.6)	(5.6)	(4.6)	(7.6)	(9.6)	(6.6)	(10.5)
Transportation and Communication	71146	32301	308157	105415	47123	46599	47165	25760	50106	16252
	82978	36666	349876	116543	54256	56715	54397	30511	55134	19600
	(3.1)	(8.1)	(1.1)	(2.1)	(6.1)	(7.1)	(5.1)	(9.1)	(4.1)	(10.1)
Health	52905	21086	206379	63139	34443	37872	34016	20898	29375	11722
	54326	21795	211977	64858	35093	39504	34828	21295	30180	12525
	(3.2)	(8.2)	(1.2)	(2.2)	(5.2)	(4.2)	(6.2)	(9.2)	(7.2)	(10.2)
Social and Economic Welfare	3974	1780	14618	4742	2916	3061	2997	1808	2419	1078
	4138	1813	15460	4940	2928	3178	2996	1807	2464	1108
	(3.7)	(9.7)	(1.7)	(2.7)	(6.7)	(4.7)	(5.7)	(8.7)	(7.7)	(10.7)
Recreation and Culture	2753	1069	10115	3035	1572	1605	1501	1039	1728	718
	2792	1098	10413	3140	1634	1748	1583	1057	1712	726
	(3.8)	(8.8)	(1.8)	(2.8)	(6.8)	(5.8)	(7.8)	(9.8)	(4.8)	(10.8)
Industrial Develop. and Resources	34227	12552	89185	39351	19756	22806	19373	12192	21687	10032
	29739	11229	125590	34539	17575	20538	17364	10798	18254	8443
	(3.4)	(8.4)	(1.4)	(2.4)	(6.4)	(4.4)	(7.4)	(9.4)	(5.4)	(10.4)
General Government	24002	9151	77709	28516	13970	14257	14149	8664	13567	5052
	24513	9516	99613	29167	14568	15587	14734	8984	13801	5447
	(3.5)	(8.5)	(1.6)	(2.5)	(6.5)	(4.5)	(5.5)	(9.5)	(7.5)	(10.6)
Public Safety Protection	39792	14823	115290	54341	22317	31380	21723	13033	22354	10329
	34177	13063	154884	45123	19805	26700	19473	11698	19151	8851
	(3.3)	(8.3)	(1.3)	(2.3)	(6.3)	(4.3)	(7.3)	(9.3)	(5.3)	(10.3)
Region Total	249293	100421	902165	320921	153581	169858	151959	90644	152440	60603
	253595	103183	1050079	321697	157949	177337	157142	93705	152182	62200

perceptibly than central core regions, the old proportions were more disparity lessening than the new ones.

5. Evaluation of the Results

Naturally the results suffer from two broad categories of difficulties: those associated with the model and those that pertain to the data to which the model was applied. Inasmuch as the model rests on questionable premises and assumptions and the data on shaky and unreliable foundations, the results are suspect in a measure that often exceeds the sum of these two difficulties as one compounds the other.

The results derived provide interesting and useful information on the impact of government expenditure and the distribution of this expenditure impact over the various regions of Ontario. Changes in budget proportions on programs have resulted in a differential impact on the regions. Therefore, different substitutions among programs within the budget may result in different patterns of income distribution among the regions.

If these questions of assessment of fiscal policy impact are important, further work in this area is necessary. The data base is admittedly poor and stands substantial improvements. The input-output table could be overhauled and reproduced to be consistent with that of Ottawa and for a more recent year than 1965. Government expenditures should be presented as a matrix and not as a vector. The household sector should be allocated properly over regions and so should consumption at least.

Chapter 9

How Efficient are Ontario Government Expenditures

A. A. Kubursi

1. Introduction

Can the Ontario government budget in 1965 or in any other year be considered efficient? Of the various multipliers discussed previously, which should be consulted when the Ontario government budget is examined for efficiency in generating income and employment?

These two questions involve a theoretical question and an empirical question. Once the theoretical question of which multiplier to consult is solved, the empirical question will no longer be difficult to solve.

In the Technical Appendix to this chapter we develop an optimization problem in which government is hypothesized to seek the maximization of employment and/or income of the province subject to a number of constraints. The solution to this programming problem defines a criterion for achieving this objective subject to the constraints of living within the budget and not violating boundary limits on individual expenditure programs. The criterion of budget efficiency requires a budget composition involving higher proportions of the budget being allocated to efficient expenditure programs. Efficient expenditure programs require that program expenditures must be absorbed into those industries whose income partial multipliers are greatest.

2. The Analytical Approach

(a) The Assumptions of the Model

The determination of efficient programs and an efficient budget rest on a number of crucial assumptions about the nature of government objectives, the nature of production and demand of the economic system and a host of other operational simplifications required to render the model applicable. As such, the results that follow from this model should not be construed to represent what would actually occur when government formulates and implements the budget. Rather, they represent what changes would occur if all the assumptions of the model were satisfied.

The following list of assumptions presents a brief account of the specific assumptions utilized in this application.

(1) The model is static and does not accommodate changes in investment and capacity;

(2) Excess capacity exists in all industries;

(3) Wages are fixed in all industries and regions. This is a consequence of assuming perfectly elastic supplies of labour in all industries and regions and fixed capital;

(4) Government is assumed to seek the maximization of employment and/or income;

(5) Leontief technology describes the technology of the economy;

(6) Government expenditure programs represent activity levels and their industrial purchases are in fixed proportion to the total program expenditure;

(7) All industrial outputs are flexible;

(8) All taxes and other charges remain fixed;

(9) A number of assumptions that pertain to the input-output tables of Ontario could justifiably be added here.

Subject to these assumptions we proceeded to compute the multipliers and ranks of the various industries and government expenditure programs.

(b) The Determination of Efficient Programs and Budgets

The aim is to identify which industries generate the highest income and employment multipliers in response to unit changes in their final demand. Having done this, we ranked these multipliers according to how large is their magnitude. Next, we ranked the magnitudes of the coefficients of the industrial purchases of each program. The correlation coefficient as a measure of association between the two ranks were computed. Those programs with positive and significant correlation coefficients were considered efficient programs. The budget that allocates high proportions of expenditures to efficient programs is considered an efficient budget.

3. Difficulties with the Approach

There are several sources of difficulties with the analytical approach as utilized here. The government is assumed to seek the maximization of employment and/or income to the neglect of several other objectives. The fact that we restrict expenditure levels on the different programs to particular intervals could be interpreted as satisfying different implicit objectives. But these implicit objectives remain vague and perhaps too implicit.

All industrial outputs are assumed flexible with no capacity bottlenecks and no foreign input constraints. The fact that we face nowadays a growing state of resource shortages and severe inflationary pressures, should cast some doubt on the validity and usefulness of these assumptions.

Wages and other value added components are taken as fixed and invariant to changes in intersectoral and/or inter-regional demands.

The static nature of our analysis is another source of difficulty. Reality is dynamic and uncertain whereas our models are static and deterministic.

Several other limitations could be cited here. The fact that the inter-regional multiplier effects are suppressed, the Ontario input-output tables are unreliable, the expenditure coefficients are questionable and the regionalization of value added is somehow arbitrary, diminish in a significant way the reliability of our results. We shall argue, however, that the plausibility of the results may still be relevant and intact.

4. The Results

In Table 1 the income and "employment income" multipliers of the various industries in Ontario together with their ranks are presented. Simple multipliers are those that exclude the induced effects generated by the consumption-income relationship; otherwise they are referred to as induced multipliers.

The highest simple income multiplier generated in Ontario per one dollar increase in its final demand is that of Communication and Other Services industry followed by Printing and Publishing; Construction is third and Tobacco and Tobacco Products is fourth. As for the induced income multipliers, the ranks remain the same, only the magnitudes change.

The highest simple "employment income" multiplier is generated by Construction, followed by Printing and Publishing; Furniture and Fixtures is third and Dairy Products is fourth.

Interestingly, the ranks of the induced employment multipliers also remain the same as those of the simple employment multipliers.

TABLE 1. INCOME & EMPLOYMENT MULTIPLIERS BY SECTOR (continued)

Sector \ Multiplier	Simple Income Multiplier		Simple Employment Multiplier		Induced Income Multiplier		Induced Employment Multiplier	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
26. Other Primary Metals	.1991	47	.1230	45	.3015	47	.2600	45
27. Fabricated and Structural Metals	.4998	15	.2458	21	.7569	15	.5196	21
28. Metal Stamping, Pressing and Coating	.5104	13	.2741	16	.7729	13	.5795	16
29. Other Metal Fabricating Industries	.4094	24	.2502	19	.6200	24	.5289	19
30. Miscellaneous Machinery	.2945	38	.1448	41	.4460	38	.3062	41
31. Motor Vehicles and Aircraft	.2504	44	.1498	37	.3792	44	.3167	37
32. Other Transportation Equipment	.3193	32	.1434	28	.4836	32	.4089	28
33. Electrical Applicances	.4964	16	.2873	12	.7517	16	.6073	12
34. Electrical Industrial Equipment	.5909	8	.3607	6	.8949	8	.7613	6
35. Communication Equipment	.4228	23	.2578	18	.6403	23	.5450	18
36. Other Electrical Products	.3063	34	.1855	29	.4639	34	.3921	29
37. Clay, Lime and Cement	.5438	12	.2776	15	.8236	12	.5868	15
38. Other Non-metallic Mineral Products	.3991	26	.2380	23	.6044	26	.5031	23
39. Petroleum Refineries and Coal Products	.2181	45	.0880	47	.3303	45	.1860	47
40. Plastics and Synthetic Resins	.3012	35	.1491	38	.4561	35	.3152	38
41. Paint and Varnish	.3813	27	.2064	27	.5774	27	.4362	27
42. Pharmaceuticals and Medicines	.2915	39	.1658	33	.4415	39	.3506	33
43. Other Chemical Industries	.3997	25	.1851	30	.6052	25	.3914	30
44. Miscellaneous Manufacturing Industries	.3501	29	.2257	25	.5301	29	.4770	25
45. Construction, Maintenance and Repair	.7132	3	.4881	1	1.0800	3	1.0317	1
46. Transportations, Storage and Trade	.5767	10	.3379	7	.8733	10	.7142	7
47. Utilities	.6091	5	.1822	31	.9224	5	.3851	31
48. Communication and Other Services	.8383	1	.2890	11	1.2694	1	.6109	11
49. Unallocated Sector	.4410	21	.2274	24	.6678	21	.4807	24

TABLE 1. INCOME & EMPLOYMENT MULTIPLIERS BY SECTOR

Sector \ Multiplier	Simple Income Multiplier		Simple Employment Multiplier		Induced Income Multiplier		Induced Employment Multiplier	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
1. Agriculture, Forestry and Fishing	.5774	9	.3263	8	.8743	9	.6898	8
2. Mining	.1530	48	.0595	48	.2317	48	.1258	48
3. Meat and Poultry	.4428	20	.2667	17	.6706	20	.5637	17
4. Dairy Products	.6012	6	.3726	4	.9103	6	.7877	4
5. Grain Mills	.3312	31	.1787	32	.5015	31	.3778	32
6. Biscuits and Bakeries	.5582	11	.3677	5	.8453	11	.7773	5
7. Sugar and Confectioneries	.2991	36	.1559	36	.4529	36	.3296	36
8. Other Food Industries	.2835	40	.1481	40	.4293	40	.3131	40
9. Soft Drinks	.3654	28	.2177	26	.5534	28	.4602	26
10. Distilleries, Breweries and Wineries	.4781	18	.1593	35	.7239	18	.3366	35
11. Tobacco and Tobacco Products	.6327	4	.2845	13	.9582	4	.6014	13
12. Rubber Products	.4561	19	.2476	20	.6907	19	.5233	20
13. Leather and Leather Products	.3332	30	.2437	22	.5045	30	.5151	22
14. Cotton Yarn Cloth	.2052	46	.1315	44	.3107	46	.2779	44
15. Synthetic Textiles	.2963	37	.1427	42	.4487	37	.3018	42
16. Knitting Mills	.5040	14	.3125	9	.7633	14	.6607	9
17. Clothing Industries	.0821	49	.0451	49	.1243	49	.0954	49
18. Other Textiles Mills	.2713	41	.1646	34	.4109	41	.3466	34
19. Sawmills	.2669	42	.1485	39	.4042	42	.3138	39
20. Furniture and Fixtures	.5977	7	.3990	3	.9050	7	.8434	3
21. Other Wood Industries	.4265	22	.2819	14	.6459	22	.5959	14
22. Pulp and Paper Mills	.2657	43	.1180	46	.4024	43	.2495	46
23. Paper Products	.4800	17	.2950	10	.7269	17	.6237	10
24. Printing and Publishing	.7362	2	.4835	2	1.1148	2	1.0220	2
25. Iron and Steel Mills	.3132	33	.1318	43	.4743	33	.2785	43

In Table 2, the ranks of the government expenditure coefficients by program and industry are presented. The Education program absorbs its highest requirements from the Communications and Other Services industry followed by Transportation, Storage and Trade; third is Printing and Publishing, fourth is Utilities. The Transportation and Communication program absorbs its highest requirement not surprisingly from Construction, second is Communication and Other Services industry; third is Clay, Lime and Cement industry and fourth is Other Metal Fabricating industries. The Health program also absorbs its highest industrial requirement from Construction. Second highest is Communication and Other Services; third is Other Chemical industries; and fourth is Agriculture.

What emerges from the study of the information in Table 2 is the fact that Communications and Other Services and Construction account between them for the highest industrial absorption shares of the various programs. Moreover, the services sectors appear to figure more significantly in the industrial bill of government expenditure than the rest of the sectors. This is in conformity with the general nature of government expenditures and operations.

Two sets of statistical tests were applied to assess the correspondence of the ranks of program industrial purchases and income and employment income multipliers. The first involved the calculation of correlation coefficients between the various pairs of observations and the results are presented in Table 3. The second procedure involved the application of Kendall's coefficient of concordance.

The results in Table 3 indicate that all the programs industrial purchases ranks are positively correlated with the

TABLE 2. INDUSTRIAL RANKS OF GOVERNMENT EXPENDITURES

Sector \ Program	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9
1. Agriculture, Forestry and Fishing	14	26	4	4	15	8	11	26	21
2. Mining	20	5	42	35	13	9	17	28	22
3. Meat and Poultry	12	27	10	2	16	10	14	32	16
4. Dairy Products	8	28	7	30	17	11	37	33	23
5. Grain Mills	18	23	22	11	18	12	22	34	24
6. Biscuits and Bakeries	21	29	20	32	19	13	39	35	25
7. Sugar and Confectioneries	22	30	21	17	20	14	38	36	26
8. Other Food Industries	19	31	19	27	21	15	25	37	27
9. Soft Drink	23	32	44	36	22	16	40	38	28
10. Distilleries, Breweries and Wineries	24	33	45	37	23	17	41	39	29
11. Tobacco and Tobacco Products	25	34	23	16	24	18	42	40	30
12. Rubber Products	26	35	40	33	25	19	26	41	31
13. Leather and Leather Products	27	36	27	22	26	20	43	30	32
14. Cotton Yarn and Cloth	28	37	31	10	27	21	44	42	33
15. Synthetic Textiles	29	38	36	38	28	22	45	43	34
16. Knitting Mills	30	39	24	34	29	23	46	44	35
17. Clothing Industries	31	24	18	24	30	24	21	45	15
18. Other Textile Mills	32	25	17	6	31	25	32	25	36
19. Sawmills	33	40	46	18	6	26	12	13	37
20. Furniture and Fixtures	13	18	16	31	32	6	15	8	19
21. Other Wood Industries	34	14	29	39	4	27	20	24	38
22. Pulp and Paper Mills	35	41	47	40	33	28	16	46	39
23. Paper Products	36	42	25	12	34	29	23	15	18
24. Printing and Publishing	3	16	12	8	8	2	3	3	5
25. Iron and Steel Mills	37	7	41	41	35	30	47	23	40

TABLE 2. INDUSTRIAL RANKS OF GOVERNMENT EXPENDITURES (continued)

Sector \ Program	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9
26. Other Primary Metals	17	43	37	9	36	31	48	22	41
27. Fabricated and Structural Metals	38	12	32	42	37	32	24	29	6
28. Metal Stamping, Pressing and Coating	39	11	43	43	12	33	30	21	42
29. Other Metal Fabricating Industries	9	4	15	14	10	34	10	4	17
30. Miscellaneous Machinery	11	22	14	29	38	35	13	9	7
31. Motor Vehicles and Aircraft	7	44	33	23	39	36	6	14	2
32. Other Transportation Equipment	40	45	48	44	40	37	29	31	43
33. Electrical Applicances	41	46	35	28	41	38	49	20	44
34. Electrical Industrial Equipment	15	21	30	45	42	39	28	18	12
35. Communication Equipment	42	47	49	46	14	40	19	10	13
36. Other Electrical Products	16	13	38	26	43	41	31	11	45
37. Clay, Lime and Cement	43	3	26	25	9	42	27	17	46
38. Other Non-metallic Mineral Products	44	19	13	47	44	43	35	27	47
39. Petroleum Refineries and Coal Products	10	10	5	5	45	44	4	12	14
40. Plastics and Synthetic Resins	45	48	34	48	46	7	36	47	9
41. Paint and Varnish	46	15	39	19	47	45	34	48	48
42. Pharmaceutical and Medicines	47	49	9	49	48	46	33	49	49
43. Other Chemical Industries	48	9	3	13	49	47	18	19	20
44. Miscellaneous Manufacturing Industries	6	17	11	21	11	48	8	7	11
45. Construction, Maintenance and Repair	49	1	1	20	3	5	7	1	4
46. Transportation, Storage and Trade	2	6	8	3	2	3	2	6	3
47. Utilities	4	8	6	7	7	49	5	5	10
48. Communications and Other Services	1	2	2	1	1	1	1	2	1
49. Unallocated Sector	5	20	28	15	5	4	9	16	8

TABLE 3 CORRELATION COEFFICIENTS AND THEIR RANKS

Program \ Multiplier	Simple Income Multiplier		Simple Employment Multiplier	
	Coefficient	Rank	Coefficient	Rank
1. Education	.159*	8	.104*	8
2. Transportation & Communication	.335	4	.202*	6
3. Health	.348	2	.332	3
4. Social & Economic Welfare	.108*	9	.073	9
5. Recreation & Culture	.410	1	.355	1
6. Home & Community	.264	6	.271	4
7. Industrial Development and Provincial Resources	.172*	7	.140*	7
8. General Government	.343	3	.340	2
9. Public Safety & Protection	.279	5	.203*	5

*Stands for the Coefficients that are not Statistically significant at 5% level for 47 degree of Freedom.

TABLE 4 COEFFICIENTS OF CONCORDANCE

Program	Coefficient of Concordance	Rank	Chi Square
1. Education	.52	9	50.21
2. Transportation & Communication	.67	4	64.10
3. Health	.67	2	64.71
4. Social & Economic Welfare	.55	8	53.17
5. Recreation & Culture	.71	1	68.24
6. Home & Community	.63	6	60.66
7. Industrial Development and Provincial Resources	.59	7	56.27
8. General Government	.67	3	64.49
9. Public Safety & Protection	.64	5	61.41

income and "employment income" multipliers of the various industries. This by itself is an interesting result. However, the extent of the magnitudes of association and correspondence and their statistical significance present a different aspect of this correspondence.

The Recreation and Culture program possesses the highest correlation coefficient for both the income and employment income classification. The magnitude of the correlation coefficient is higher for the income multipliers than that of "employment income" multipliers. The rank correlation test of significance at the (.01) level shows that it is statistically significant for both cases.

The Health program also displays a significant correlation coefficient for income and employment. In the case of income multipliers it ranks second, whereas it ranks third in the latter case; the General Government program now displaces Health in the employment income multipliers case. The Education program as well as the Recreation and Culture program reveal low correlation coefficients in both cases. The Transportation and Communication program ranks fourth when the income multipliers are considered, whereas it ranks sixth in the case of employment multipliers.

In Table 4 another coefficient of association was applied. The results indicate a rather strong concordance between the ranks of income multipliers and ranks of industrial purchases of the Recreation and Culture program. The coefficient of concordance of this program is (.71), which is the highest coefficient. The lowest is that associated with the Education program. Of interest here is the fact that the concordance coefficients obey the Chi-Square distribution and that all the coefficients are significant at the (.005) level of significance with 48 degress of freedom.

In Table 5, the percentage allocation of the Ontario Budget over the various programs between 1965/66 and 1971/72 are presented. It is clearly demonstrated that the association between the efficient programs and the budget proportions allocated to these programs is rather weak. It is sufficient to point out that the most efficient program receives the lowest budget proportion over the whole period. However, it is also true that Health which accounts for the largest proportion of the budget from 1969/70 onward commands a relatively high standing and that the increased expenditures on this program therefore represent an improvement in the efficiency of the budget. The decline in the proportions of the budget allocated to Education also plays a similar role.

The determination of the efficiency of the government budget (expenditure side only) in terms of its income and employment generation potential in the various regions, requires the prior determination of the various income and employment multipliers in the various regions. Tables 6 and 7 present information relating to income multipliers and employment multipliers as well as their ranks respectively. Since the differences in ranking among industries are minimal when simple and induced multipliers are concerned, only the induced multipliers are considered.

Different industries generate the largest income and employment multipliers in the various regions and this is sufficient to result in different efficient programs for most regions. For instance, Synthetic Textiles is the leading industry in Eastern Ontario, Electrical Industrial Equipment in Lake Ontario, Printing and Publishing in Central Ontario, Iron and Steel in Niagara region, Agriculture, Forestry and Fishing in Lake Erie region and Georgian Bay region, Distilleries, Breweries and Wineries in Lake St. Clair region, Tobacco and Tobacco Products in Midwestern Ontario region and Northwestern Ontario and Sawmills in Northeastern Ontario.

TABLE 5 PROVINCIAL GOVERNMENT EXPENDITURES BY PROGRAM

"Percents"

Program \ Year	1965/66	1966/67	1967/68	1968/69	1969/70	1970/71	1971/72
1. Education	7	10	7	16	16	7	5
2. Transportation and Communication	50	37	40	35	27	28	18
3. Health	13	11	26	23	33	34	53
4. Social Welfare	1	1	3	2	-	2	2
5. Recreation & Culture	-	1	2	1	2	33	2
6. NAT. Resources, trade	8	6	7	7	5	3	2
7. General Governments & Development	10	8	9	8	6	18	14
8. Protection of persons and property	9	5	6	8	7	5	4

Employment multipliers tend to be different than income multipliers but they seem to follow more or less the same general pattern detected in Table 6, namely different industries seem to generate differential impacts in the various regions. Construction generates the highest employment multiplier in Eastern Ontario, Lake Erie and Lake St. Clair, Electrical Industrial Equipments in Lake Ontario and Niagara, Printing and Publishing in Central Ontario, Furniture and Fixtures in Midwestern and Georgian Bay regions, Sawmills in Northeastern Ontario, and Paper Products in Northwestern Ontario region.

The correlation coefficients of the ranks of the various programs industrial purchases with the regional

TABLE 6. REGIONAL INCOME MULTIPLIER INDUSTRY BY REGION

Program \ Region	1		2		3		4		5		6		7		8		9		10	
1. Agriculture, Forestry and Fishing	.086	8	.051	3	.229	32	.099	21	.114	1	.100	2	.101	4	.069	1	.053	9	.029	4
2. Mining	.012	48	.006	48	.054	49	.017	48	.008	48	.011	48	.008	49	.005	48	.097	2	.015	18
3. Meat and Poultry	.057	19	.038	9	.230	31	.074	27	.067	9	.064	11	.077	9	.041	5	.033	24	.018	14
4. Dairy Products	.108	5	.250	5	.275	20	.104	20	.106	2	.082	6	.088	6	.055	3	.050	12	.026	6
5. Grain Mills	.043	32	.033	14	.155	38	.062	32	.069	7	.041	25	.048	23	.028	15	.023	31	.013	21
6. Biscuits and Bakeries	.082	9	.026	20	.409	5	.083	26	.065	11	.055	15	.050	21	.025	16	.038	19	.019	13
7. Sugar and Confectioneries	.029	41	.014	40	.245	26	.047	42	.031	28	.031	33	.027	32	.011	37	.015	44	.008	36
8. Other Food Industries	.039	36	.030	16	.154	39	.053	39	.031	30	.055	16	.031	29	.018	24	.017	41	.011	26
9. Soft Drinks	.069	13	.019	33	.248	24	.061	35	.029	31	.039	26	.029	31	.018	23	.030	27	.014	20
10. Distilleries, Breweries and Wineries	.045	30	.029	17	.290	18	.061	34	.064	12	.155	1	.069	11	.015	30	.023	30	.011	23
11. Tobacco and Tobacco Products	.067	14	.034	12	.323	12	.130	10	.105	3	.097	3	.130	1	.040	6	.040	16	.021	12
12. Rubber Products	.048	24	.030	15	.256	23	.110	16	.058	15	.032	31	.113	2	.019	21	.019	38	.009	32
13. Leather and Leather Products	.041	34	.024	26	.206	34	.066	43	.040	26	.025	39	.080	7	.025	17	.016	42	.008	38
14. Cotton Yarn Cloth	.044	31	.014	39	.069	47	.109	17	.017	42	.012	47	.031	28	.006	47	.008	48	.004	48
15. Synthetic Textiles	.156	1	.036	10	.106	42	.038	45	.019	36	.025	38	.041	26	.011	38	.014	46	.007	40
16. Knitting Mills	.082	10	.026	21	.296	16	.120	12	.075	5	.032	32	.097	5	.016	26	.021	34	.010	28
17. Clothing Industries	.011	49	.004	49	.067	48	.013	49	.006	49	.005	49	.012	48	.003	49	.003	49	.002	49
18. Other Textile Mills	.052	22	.020	31	.178	36	.070	28	.015	44	.030	35	.058	16	.013	32	.012	47	.007	43
19. Sawmills	.048	25	.021	30	.087	46	.025	47	.016	43	.017	45	.022	38	.032	12	.118	1	.022	11
20. Furniture and Fixtures	.071	12	.035	11	.523	4	.083	25	.046	21	.046	22	.102	3	.057	2	.034	23	.014	19
21. Other Wood Industries	.063	17	.025	23	.230	30	.063	31	.062	13	.036	28	.047	24	.039	9	.060	8	.024	8
22. Pulp and Paper Mills	.046	28	.012	41	.087	45	.052	41	.012	46	.016	46	.012	47	.007	44	.070	5	.090	1
23. Paper Products	.053	21	.025	24	.379	6	.093	23	.041	23	.033	30	.034	27	.016	27	.032	25	.025	7
24. Printing and Publishing	.112	3	.029	18	.597	1	.104	19	.058	16	.057	14	.053	20	.028	14	.050	13	.034	3
25. Iron and Steel Mills	.021	45	.009	45	.091	44	.218	1	.013	45	.017	44	.015	44	.010	42	.076	4	.006	45

TABLE 6. REGIONAL INCOME MULTIPLIER INDUSTRY BY REGION (continued)

Program \ Region	1		2		3		4		5		6		7		8		9		10	
26. Other Primary Metals	.028	43	.008	46	.098	43	.053	40	.017	41	.024	40	.014	45	.006	46	.052	10	.004	47
27. Fabricated and Structural Metals	.040	35	.023	28	.361	8	.172	3	.026	33	.049	19	.022	37	.013	35	.039	17	.016	16
28. Metal Stamping, Pressing and Coating	.043	33	.017	35	.323	13	.172	4	.047	20	.046	23	.055	18	.019	22	.045	15	.010	27
29. Other Metal Fabricating Industries	.037	38	.026	19	.238	29	.119	13	.040	24	.045	24	.056	17	.022	19	.031	26	.008	34
30. Miscellaneous Machinery	.022	44	.012	42	.219	33	.106	18	.018	39	.022	42	.015	43	.010	40	.020	35	.005	46
31. Motor Vehicles and Aircraft	.021	46	.009	44	.204	35	.062	33	.017	40	.062	12	.018	40	.007	43	.015	43	.007	42
32. Other Transportation Equipment	.036	39	.016	37	.112	41	.142	7	.072	6	.021	43	.017	42	.037	10	.021	33	.012	22
33. Electrical Appliances	.047	26	.024	27	.305	15	.149	6	.055	17	.031	34	.061	14	.037	11	.038	20	.010	29
34. Electrical Industrial Equipment	.047	27	.098	1	.325	11	.217	2	.042	22	.037	27	.071	10	.016	25	.036	21	.011	25
35. Communication Equipment	.071	11	.039	8	.286	19	.070	29	.054	18	.027	37	.049	22	.014	31	.026	28	.008	35
36. Other Electrical Products	.028	42	.019	34	.264	22	.054	38	.023	35	.022	41	.019	39	.010	41	.021	32	.006	44
37. Clay, Lime and Cement	.016	18	.051	4	.343	10	.125	11	.066	10	.047	21	.062	13	.020	20	.039	18	.016	17
38. Other Non-metallic Mineral Products	.035	40	.025	25	.248	25	.135	8	.031	29	.070	8	.024	35	.011	36	.019	37	.009	31
39. Petroleum Refineries and Coal Products	.020	47	.008	47	.136	40	.029	46	.012	47	.052	18	.013	46	.007	45	.046	14	.009	30
40. Plastics and Synthetic Resins	.055	20	.022	29	.176	37	.060	36	.019	38	.061	13	.026	33	.011	39	.019	39	.008	39
41. Paint and Varnish	.039	37	.014	38	.314	14	.065	30	.032	27	.054	17	.022	36	.013	33	.020	36	.009	33
42. Pharmaceuticals and Medicines	.046	29	.011	43	.243	27	.040	44	.019	37	.034	29	.018	41	.013	34	.015	45	.007	41
43. Other Chemical Industries	.064	16	.017	36	.240	28	.094	22	.026	32	.090	5	.026	34	.015	28	.026	29	.011	24
44. Miscellaneous Manufacturing Industries	.051	23	.019	32	.264	21	.055	37	.025	34	.028	36	.030	30	.015	29	.019	40	.008	37
45. Construction, Maintenance and Repair	.111	4	.042	7	.464	3	.135	9	.067	8	.074	7	.069	12	.040	7	.061	7	.023	10
46. Transportations, Storage and Trade	.090	7	.034	13	.368	7	.112	15	.052	19	.064	10	.053	19	.030	13	.051	11	.023	9
47. Utilities	.105	6	.043	6	.354	9	.113	14	.058	14	.068	9	.058	15	.040	8	.062	6	.027	5
48. Communication and Other Services	.141	2	.056	2	.509	2	.155	5	.080	4	.092	4	.079	8	.053	4	.077	3	.036	2
49. Unallocated Sector	.066	15	.026	22	.292	17	.084	24	.040	25	.047	20	.042	2[illegible]	.023	18	.036	22	.018	15

TABLE 7. REGIONAL EMPLOYMENT MULTIPLIERS INDUSTRY BY REGION

Program \ Region	1		2		3		4		5		6		7		8		9		10	
1. Agriculture, Forestry and Fishing	.049	13	.022	12	.192	28	.064	23	.042	11	.045	10	.042	17	.024	7	.027	16	.013	11
2. Mining	.009	48	.004	48	.037	49	.011	48	.005	48	.007	49	.006	49	.003	48	.035	8	.007	32
3. Meat and Poultry	.038	23	.019	21	.202	26	.055	28	.032	21	.036	19	.047	10	.019	13	.021	27	.010	21
4. Dairy Products	.076	4	.031	3	.258	9	.087	12	.055	3	.054	4	.052	7	.029	5	.034	9	.017	6
5. Grain Mills	.029	36	.016	26	.126	37	.043	37	.032	20	.024	36	.028	26	.014	25	.015	38	.008	25
6. Biscuits and Bakeries	.075	5	.020	17	.357	4	.084	15	.052	5	.049	6	.045	12	.020	12	.033	12	.017	7
7. Sugar and Confectioneries	.023	42	.009	42	.158	30	.039	40	.021	31	.020	41	.020	33	.007	41	.011	45	.005	41
8. Other Food Industries	.024	41	.012	35	.117	39	.038	41	.017	36	.034	23	.019	35	.009	34	.011	44	.006	35
9. Soft Drinks	.053	12	.016	29	.198	27	.053	29	.024	27	.031	25	.026	27	.014	23	.024	22	.010	18
10. Distilleries, Breweries and Wineries	.026	39	.013	34	.138	33	.036	43	.028	24	.045	9	.025	29	.008	38	.013	40	.006	36
11. Tobacco and Tobacco Products	.040	20	.017	23	.202	25	.067	22	.051	6	.047	8	.045	14	.017	16	.023	25	.011	15
12. Rubber Products	.037	24	.023	10	.208	23	.075	20	.029	23	.026	33	.075	2	.015	17	.016	34	.007	29
13. Leather and Leather Products	.040	22	.023	11	.217	19	.049	32	.032	19	.025	35	.071	3	.021	11	.016	35	.007	30
14. Cotton Yarn and Cloth	.033	31	.011	39	.073	44	.082	16	.015	37	.013	46	.029	24	.005	44	.008	48	.004	47
15. Synthetic Textiles	.078	3	.021	14	.087	41	.030	45	.014	38	.017	42	.025	28	.008	37	.010	47	.005	44
16. Knitting Mills	.061	9	.021	15	.264	8	.101	7	.060	2	.031	27	.065	4	.014	24	.020	28	.009	22
17. Clothing Industries	.008	49	.003	49	.048	48	.010	49	.004	49	.005	49	.008	48	.002	49	.003	49	.001	49
18. Other Textile Mills	.035	28	.014	30	.133	35	.048	35	.014	40	.023	38	.033	21	.009	36	.011	46	.005	39
19. Sawmills	.035	30	.013	33	.085	43	.025	46	.013	43	.015	44	.017	40	.018	14	.071	1	.016	8
20. Furniture and Fixtures	.063	7	.030	4	.379	3	.082	17	.043	10	.044	11	.090	1	.051	1	.031	13	.013	12
21. Other Wood Industries	.054	11	.020	16	.224	18	.060	26	.048	7	.035	21	.042	16	.033	3	.046	3	.018	4
22. Pulp and Paper Mills	.027	38	.007	45	.069	47	.036	42	.009	46	.012	47	.010	46	.005	46	.034	10	.035	1
23. Paper Products	.045	17	.020	19	.319	5	.077	18	.035	16	.031	26	.032	22	.013	27	.024	19	.015	10
24. Printing and Publishing	.094	2	.027	7	.534	1	.101	6	.054	4	.054	3	.058	9	.026	6	.040	4	.022	2
25. Iron and Steel Mills	.016	46	.006	46	.073	45	.096	9	.010	45	.013	45	.011	45	.006	43	.037	7	.004	46

TABLE 7. REGIONAL EMPLOYMENT MULTIPLIERS INDUSTRY BY REGION (continued)

Program \ Region	1		2		3		4		5		6		7		8		9		10	
26. Other Primary Metals	.023	43	.008	44	.086	42	.041	39	.013	44	.024	37	.013	43	.005	45	.039	5	.004	48
27. Fabricated and Structural Metals	.032	33	.017	24	.232	16	.102	4	.020	33	.039	15	.020	32	.010	30	.026	18	.012	13
28. Metal Stamping, Pressing and Coating	.037	25	.014	32	.251	12	.105	3	.033	18	.036	17	.039	19	.015	20	.029	15	.008	23
29. Other Metal Fabricating Industries	.035	29	.021	13	.208	24	.090	11	.031	22	.090	13	.045	13	.017	15	.024	21	.008	26
30. Miscellaneous Machinery	.018	45	.010	40	.127	36	.076	19	.014	39	.016	43	.013	44	.008	39	.014	39	.004	45
31. Motor Vehicles and Aircraft	.019	44	.008	43	.134	34	.045	35	.014	41	.039	14	.016	42	.007	42	.012	41	.005	38
32. Motor Transportation Equipment	.033	32	.012	36	.116	40	.101	5	.043	9	.020	40	.018	39	.031	4	.016	32	.011	17
33. Electrical Appliances	.042	19	.020	18	.251	11	.096	8	.046	8	.029	28	.050	8	.024	8	.027	17	.008	24
34. Electrical Industrial Equipment	.045	16	.084	1	.295	7	.142	1	.036	15	.037	16	.052	6	.015	19	.030	14	.010	19
35. Communication Equipment	.055	10	.028	6	.243	14	.062	24	.033	17	.027	32	.046	11	.012	28	.022	26	.007	28
36. Other Electrical Products	.025	40	.016	28	.209	22	.043	36	.020	32	.020	39	.019	37	.009	35	.017	30	.006	37
37. Clay, Lime and Cement	.047	14	.028	5	.252	10	.085	14	.038	13	.036	18	.039	18	.015	18	.024	20	.011	14
38. Other Non-metallic Mineral Products	.032	34	.020	20	.215	20	.087	13	.025	26	.059	2	.022	31	.010	29	.016	33	.007	27
39. Petroleum Refineries and Coal Products	.014	47	.005	47	.072	46	.019	47	.008	47	.026	34	.009	47	.005	47	.019	29	.005	43
40. Plastics and Synthetic Resins	.036	26	.014	31	.125	38	.042	38	.014	42	.034	22	.019	38	.008	40	.012	42	.005	42
41. Paint and Varnish	.030	35	.011	37	.227	17	.050	30	.021	30	.036	20	.019	36	.010	33	.015	37	.007	34
42. Pharmaceuticals and Medicines	.028	37	.009	41	.184	29	.034	44	.017	35	.028	29	.016	41	.010	32	.012	43	.005	40
43. Other Chemical Industries	.036	27	.011	38	.157	31	.060	25	.018	34	.048	7	.019	34	.010	31	.015	36	.007	33
44. Miscellaneous Manufacturing Industries	.046	15	.017	22	.235	15	.050	31	.022	29	.027	31	.028	25	.014	26	.017	31	.007	31
45. Construction, Maintenance and Repair	.102	1	.038	2	.441	2	.124	2	.060	1	.071	1	.065	5	.036	2	.053	2	.021	3
46. Transportation, Storage and Trade	.070	6	.026	8	.299	6	.090	10	.040	12	.051	5	.043	15	.023	9	.038	6	.017	5
47. Utilities	.040	21	.016	27	.152	32	.047	34	.023	28	.028	30	.024	30	.015	22	.023	23	.010	20
48. Communications and Other Services	.062	8	.024	9	.248	13	.074	21	.036	14	.043	12	.037	20	.023	10	.034	11	.015	9
49. Unallocated Sector	.044	18	.017	25	.213	21	.059	27	.027	25	.032	24	.029	23	.015	21	.023	24	.011	16

TABLE 8. REGIONAL INCOME CORRELATION COEFFICIENTS AND THEIR RANK

Program by Region*

Region / Program	1		2		3		4		5	
	Coefficient	Rank	Coefficient	Rank	Coefficient	Rank	Coefficient	Rank	Coefficient	Rank
1. Education	.114	7	.197	5	.092	7	-.079	9	.132	5
2. Transportation and Communication	-.021	9	.102	9	.316	2	.245	2	.023	7
3. Health	.343	3	.276	3	.280	4	.110	3	.221	3
4. Social and Economic Welfare	.240	4	.132	8	.078	8	-.042	6	.147	4
5. Recreation and Culture	.488	1	.458	1	.202	6	.003	5	.439	1
6. Home and Community	.429	2	.319	2	.030	9	-.075	8	.292	2
7. Industrial Development and Resources	.158	6	.139	7	.215	5	-.047	7	.000	9
8. General Government	.096	8	.182	6	.426	1	.264	1	.070	6
9. Public Safety and Protection	.226	5	.208	4	.292	3	.072	4	.020	8

*The coefficients of correlations that do not exceed .25 are not significant at the 5% level.

TABLE 8. REGIONAL INCOME CORRELATION COEFFICIENTS AND THEIR RANK (continued)

Program by Region*

Region / Program	6		7		8		9		10	
	Coefficient	Rank	Coefficient	Rank	Coefficient	Rank	Coefficient	Rank	Coefficient	Rank
1. Education	.197	7	.206	5	.224	7	.189	5	.196	8
2. Transportation and Communication	.242	4	.016	8	.104	8	.405	3	.211	7
3. Health	.528	1	.271	3	.350	3	.028	9	.260	6
4. Social and Economic Welfare	.288	3	.224	4	.293	4	.165	7	.270	4
5. Recreation and Culture	.132	8	.430	1	.535	1	.423	2	.498	1
6. Home and Community	.217	6	.381	2	.369	2	.171	6	.438	3
7. Industrial Development and Resources	.240	5	-.042	9	.247	6	.359	4	.459	2
8. General Government	.083	9	.081	7	.268	5	.453	1	.163	9
9. Public Safety and Protection	.323	2	.108	6	.104	9	.163	8	.270	5

*The coefficients of correlations that do not exceed .25 are not significant at the 5% level.

TABLE 9. REGIONAL EMPLOYMENT CORRELATION COEFFICIENTS AND THEIR RANK

Program by Region*

Program \ Region	1		- 2		3		4		5	
	Coefficient	Rank	Coefficient	Rank	Coefficient	Rank	Coefficient	Rank	Coefficient	Rank
1. Education	.108	7	.149	7	.057	8	-.081	8	.069	7
2. Transportation and Communication	.081	8	.169	6	.229	4	.261	2	.092	5
3. Health	.267	3	.277	4	.278	2	.123	3	.249	3
4. Social and Economic Welfare	.079	9	.042	9	.003	9	-.113	9	.044	8
5. Recreation and Culture	.489	1	.431	1	.275	3	.110	4	.392	1
6. Home and Community	.355	2	.287	3	.134	6	.036	6	.287	2
7. Industrial Development and Resources	.110	6	.136	8	.104	7	-.026	7	.013	9
8. General Government	.260	4	.350	2	.376	1	.323	1	.218	4
9. Public Safety and Protection	.235	5	.232	5	.192	5	.098	5	.074	6

*Correlation coefficients that fall short of .25 are not significant at the 95 level of confidence.

TABLE 9. REGIONAL EMPLOYMENT CORRELATION COEFFICIENTS AND THEIR RANK (continued)

Program by Region*

Region / Program	6		7		8		9		10	
	Coefficient	Rank	Coefficient	Rank	Coefficient	Rank	Coefficient	Rank	Coefficient	Rank
1. Education	.109	8	.127	6	.131	7	.149	6	.112	8
2. Transportation and Communication	.298	3	.054	8	.158	6	.346	3	.202	5
3. Health	.457	1	.234	3	.278	4	.002	9	.156	7
4. Social and Economic Welfare	.091	9	.110	7	.122	8	.056	8	.082	9
5. Recreation and Culture	.200	7	.399	1	.480	1	.452	2	.528	1
6. Home and Community	.229	5	.338	2	.306	3	.231	5	.344	3
7. Industrial Development and Resources	.208	6	-.026	9	.215	5	.267	4	.373	2
8. General Government	.260	4	.196	4	.352	2	.483	1	.299	4
9. Public Safety and Protection	.306	2	.138	5	.104	9	.109	7	.191	6

*Correlation coefficients that fall short of .25 are not significant at the 95 level of confidence.

income and employment multipliers are presented in Tables 8 and 9, respectively. A striking feature common to both tables is the presence of negative correlation coefficients. This signifies that the budget is rather awkwardly inefficient in that region. In other words, the expenditure programs seem to purchase industrial products in large proportions from industries with low income multipliers in the given region.

In Eastern Ontario the Transportation and Communication program displays a negative correlation coefficient. Given that up until 1969 this program absorbed a large proportion of the Ontario government budget, the impact of the budget on this region must have been differentially negative inasmuch as its correlation coefficient for the other regions is positive. The leading three programs for the region in terms of positive and significant correlation coefficients are the Recreation and Culture, followed by the industrial Development and Resources programs. Third is the Health program. In Lake Ontario region, none of the programs shows a negative correlation coefficient and a few show a significantly positive correlation coefficients. These include Recreation and Culture, Industrial Development and Resources and Health.

In Central Ontario region, again no program is associated with a negative correlation coefficient. General Government possesses the highest correlation coefficient, followed by Transportation and Communication. Third is Protection and Public Safety. In Niagara, General Government, Transportation and Communication and Health represent the three programs with positive correlations coefficients. In this region, however, Education, Social and Economic Welfare, Home and Community and Industrial Development and Provincial Resources all show a negative correlation coefficient. It must be pointed out, however, that none of these negative coefficients is statistically significant at even the ten percent level. In Lake Erie region, Recreation and Culture, Home and Community and Health represents the three programs with high and positive correlation coefficients. Only one program shows a zero correlation coefficient, the rest are all positive.

In Lake St. Clair, the Health program displays a positive and significant correlation coefficient. Given the increased importance of this program in the total Ontario budget, this region would stand to gain from such a development and trend. Public Safety and Protection displays the second highest and most significant correlation in this region. Social and Economic Welfare ranks third with a correlation coefficient of .29. In Midwestern Ontario, the Industrial Development and Provincial Resources shows a negative correlation, otherwise the rest of the programs show positive correlations. Again Recreation and Culture, Home and Community and Health reveal the three largest correlation coefficients. In Georgian Bay, the poorest region, Recreation and Culture shows the most significant positive correlation as one might expect, Home and Community and Health fare well too. In Northeastern Ontario region, the General Government program displays the highest positive correlation, Recreation and Culture ranks second and Transportation and Communication ranks third. In the Northwestern region, Recreation and Culture, followed by the Industrial Development and Provincial Resources and the Home and Community program are the most efficient programs.

It is interesting to note that generally different mixes of programs account for the efficient mix. With the exception of some concentration of negative correlations in the Niagara region, most programs seem to have positive correlation coefficients. The prominence of Health -- which represents a program that is assuming a greater share of the budget -- in the various regions as one that is highly correlated with the industries that generate large income multipliers, is a significant fact that can be exploited towards improving the comparative regional efficiency of government expenditure.

In Table 9, the correlation coefficients of the various programs with the industrial employment multipliers in each region are presented. Significant similarities exist between the results in Tables 8 and 9, which saves us the trouble of analyzing the results in great detail.

Again with the marked exception of the Niagara region, the correlation coefficients are almost all positive. The Recreation and Culture program and General Government between them account for most of the highest positive correlations in Table 9, with the exception of Health in Lake St. Clair.

5. Evaluation of the Results

A number of points have been developed in this section that could be summarized as follows:

(1) A budget efficiency criterion has been developed and applied to the Ontario government expenditure from 1965 to 1972. A statistically significant correspondence is detected among government purchases from industries with large income multipliers. The strength of this correspondence appears to be differential, i.e., different programs have different coefficients of correlations between the rank of their industrial purchases and the income multipliers of the various industries.

(2) The regional income generation of the budget is similarly assessed. Here a significant degree of variation in the correspondence coefficients is revealed. Certain regions tend to show a concentration of programs with significant efficiencies. The Niagara region, on the other hand, shows a preponderance of inefficient programs.

(3) Finally, we must recognize the limitations on the applicability of our model and the incompleteness of the data we have used; nevertheless, the reader should be convinced of the effectiveness of our method by the very plausible results derived in this section.

Appendices

Technical Appendix to Chapter 1

J. Bossons

In this appendix, the structure and solution of input-output models is described more formally to supplement the verbal description contained in Chapter 1.

A. Solving the simple model: an example

The sequence of adjustments in industry output caused by a policy-induced change in the final demand for the product of one industry can easily be traced out using the notation utilized in Section 2(a) of Chapter 1. The simplified three-industry example shown in Figure 1 of Chapter 1 is used as illustration.

Let ΔF_1 denote the policy-induced change in the demand for output of industry 1 and assume that no other changes occur in final demands. (Feedback effects through changes in aggregate demand are ignored here; they are introduced in the next subsection.) The initial effect of the policy is thus to change the output of industry 1, as follows (again using the prefix "Δ" to denote change in the variable prefixed):

$$\Delta Q_1 = \Delta F_1$$

The materials requirements of industry 1 cause changes in the output of industry 2:

$$\Delta Q_2 = a_{21} \; \Delta Q_1,$$

where a_{21} = ratio to output of industry 1 of input required from industry 2 to produce the industry 1 output.

Because of the material requirements of industry 2, this change in industry 2 output causes changes in demand for output of industries 1 and 3. At the third level of adjustment, we thus have

$$\Delta Q_1 = \Delta F_1 + a_{12}\Delta Q_2$$

$$\Delta Q_3 = a_{32}\Delta Q_2$$

In the first of these two equations, we now have industry 1 output changed both by the direct effect of ΔF_1 and by the additional industry 1 output used by industry 2. The change in industry 3 output induces further changes in the use of materials produced by industries 1 and 2, denoted respectively by $a_{13}\Delta Q_3$ and by $a_{23}\Delta Q_3$.

Putting this all together, we thus have the following three equations relating the output of each industry after each adjustment to the industry outputs prior to that adjustment:

$$\Delta Q_1^{(k+1)} = \Delta F_1 + a_{12}\Delta Q_2^{(k)} + a_{13}\Delta Q_3^{(k)}$$

$$\Delta Q_2^{(k+1)} = a_{21}\Delta Q_1^{(k)} + a_{23}\Delta Q_3^{(k)}$$

$$\Delta Q_3^{(k+1)} = a_{32}\Delta Q_2^{(k)}$$

In the above equation, k is used to identify the number of adjustments which have occurred. The sequence of initial adjustments is shown in Table A.

Table A

SEQUENTIAL ADJUSTMENTS IN ΔQ_i

Industry	Initial Effect	Adjustments 1	2	3
1	ΔF_1	--	$a_{12}a_{21}\Delta F_1$	$a_{13}a_{32}a_{21}\Delta F_1$
2	--	$a_{21}\Delta F_1$	--	$a_{21}a_{12}a_{21}\Delta F_1 + a_{23}a_{32}a_{21}\Delta F_1$
2	--	--	$a_{32}a_{21}\Delta F_1$	--

The relationship between the values of ΔQ_i after each adjustment and the values of ΔQ_i before that adjustment can more easily be seen if the relationships are expressed in matrix form. To do so, let

$$\Delta Q = \begin{bmatrix} \Delta Q_1 \\ \Delta Q_2 \\ \Delta Q_3 \end{bmatrix} \qquad \Delta F = \begin{bmatrix} \Delta F_1 \\ 0 \\ 0 \end{bmatrix}$$

$$A = \begin{bmatrix} 0 & a_{12} & a_{13} \\ a_{21} & 0 & a_{23} \\ 0 & a_{32} & 0 \end{bmatrix}$$

The adjustment sequence can then be written as

$$\Delta Q^{(k+1)} = \Delta F + A\Delta Q^{(k)} \quad .$$

The notion of convergence alluded to in Section 1 of Chapter 1 implies that this sequence will settle down into a new steady state in which

$$\Delta Q^{(k+1)} = \Delta Q^{(k)}$$

which implies that at this new equilibrium

$$\Delta Q = \Delta F + A\Delta Q$$

or in other words that

$$\Delta Q = (I-A)^{-1} \Delta F \quad ,$$

where I is the identity matrix.

The condition for the existence of a solution is that the matrix $(I-A)$ may be inverted. It can be shown that this condition is valid in simple input-output models.

B. The simple model with aggregate demand feedbacks

Under the assumption that aggregate demand can be modelled in a short-run Keynesian framework (i.e., assuming fixed wages and prices and a perfectly-elastic supply of labor), the change in final demands arising from a policy change need to be expanded to incorporate the changes in aggregate demand induced by changes in consumers' disposable income resulting from changes in employment. Under the assumption that wage income in each industry is a constant fraction of industry output, that industry "surplus" (value added at fixed market prices less wage bill) is consequently also proportionate to output, and that taxes on each form of income are also a fixed proportion of before-tax income, the change in disposable income of consumers can be written as

$$\Delta Y = \Sigma_{i=1}^{N} \left[W_i(1-t_w) + \lambda(1-W_i)\right] \Delta Q_i$$

where ΔY = change in consumers' disposable income

W_i = fraction of value-added paid to labor in industry i

t_w = average tax rate on wages

λ = fraction of profits and other non-wage components of value-added received by households after tax

ΔQ_i = change in output of industry i

With the further assumption that the induced change on expenditures on the products of each industry is proportional to ΔY, the feedback effects of induced consumption changes can simply be added to the equation defining the demand for the output of each industry. These equations thus become (in the case of the simple materials flow model):

$$\Delta Q_i = \Delta F_i + \Sigma_{j=1}^{N} a_{ij} \Delta Q_j + \frac{Q_i}{Y} \Delta Y$$

where ΔF_i = initial change in final demand for products of industry i

a_{ij} = the ratio of inputs from industry i used by industry j to output of industry j

Q_i = initial production level for industry i

Y = initial aggregate demand

Putting these equations together to solve for the predicted changes in industry output (ΔQ_i) is simply a matter of setting up the equations in matrix form and solving for ΔQ . As before, let

$$\Delta Q = \begin{bmatrix} \Delta Q_1 \\ \cdots \\ \Delta Q_N \end{bmatrix} \qquad \Delta F = \begin{bmatrix} \Delta F_1 \\ \cdots \\ \Delta F_N \end{bmatrix}$$

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots \\ a_{21} & a_{22} & \cdots \\ \cdots & \cdots & \cdots \\ \cdots & \cdots & a_{NN} \end{bmatrix}$$

and define two new NXN matrices

$$G = \begin{bmatrix} g_1 & g_2 & \cdots & g_N \\ g_1 & g_2 & \cdots & g_N \\ \cdots & \cdots & \cdots & \cdots \\ g_1 & g_2 & \cdots & g_N \end{bmatrix} \qquad H = \begin{bmatrix} h_1 & 0 & \cdots & 0 \\ 0 & h_2 & \cdots & 0 \\ \cdots & \cdots & \cdots & \cdots \\ 0 & 0 & \cdots & h_N \end{bmatrix}$$

where

$$g_i = W_i(1-t_w) + \lambda(1-W_i)$$

$h_i = \frac{Q_i}{Y}$ = fraction of consumption allocated to expenditures on products of industry i

Then the change in demand for each industry can be written as

$$\Delta Q = \Delta F + A\Delta Q + HG\Delta Q$$

which, on solution, becomes

$$\Delta Q = (I-A-HG)^{-1}\ \Delta F\ .$$

The solution of this model is thus a straightforward extension of the solution of the simple materials flow model.

Technical Appendix to Chapters 3 and 7

R.W. Boadway and J.M. Treddenick

In this Appendix, mathematical derivations are provided for the construction of the interregional input-output tables as discussed in Chapter 3 and for the output and labour multipliers as discussed in Chapter 7. We first present a summary of the notation used (in the order which it appears).

A. Notation

A transpose is indicated by a prime; a diagonal matrix is indicated by a circumflex (^); a dot represents the operation of multiplying each element of a matrix by the corresponding element in the other; an asterisk denotes a rate of change.

n = number of industries in each region (=16)

o = superscript denoting Ontario

c = superscript denoting Rest of Canada

$\bar{c}$ = superscript denoting Canada

f = superscript denoting foreign countries

X^{ij} = (n x n) matrix of intermediate flows from industries in i into industries in j $(i,j = o,c,\bar{c})$

Y^{ij} = (n x 3) matrix of flows of final demands from industries in i to users in j $(i,j = o,c)$

C^{ij}, I^{ij}, G^{ij} = (n x 1) components of Y^{ij}; Consumption, Investment and Government Expenditures

X^{ont}, Y^{ont}, C^{ont}, etc. = entries in published Ontario Tables

X^{can}, Y^{can}, C^{can}, etc. = entries in published Canadian Tables

E^{if} = (n x 1) vector of Exports from region i to foreigners $(i = o,c)$

M^{if} = (n x 1) vector of Imports to industries in region i from foreign sources $(i = o,c)$

V^{i} = (3 x n) matrix of primary inputs in industries in region i $(i = o,c)$

W^i, S^i, O^i = (1 x n) components of V^i (Wages & Salaries, Surplus, and Other Value-added)

μ^{ij} = (n x 1) import coefficients from region i into region j (i = o,c,$\bar{c}$,f; j = o,c,$\bar{c}$)

A^{ij} = (n x n) matrix of input-output coefficients from industries in region i into industries in region j (i,j = o,c)

V^i = (3 x n) matrix of primary input coefficients in region i (i = o,c)

w^i, s^i = (1 x n) vectors of Wage & Salary and Surplus coefficients in region i (i = o,c)

m^i = (1 x n) vector of industry import coefficients (i = o,c)

E^i = aggregate consumption expenditures in region i (i = o,c)

c^i = marginal propensity to consume in region i (i = o,c)

Y_d^i = disposable income in region i (i = o,c)

P^i = (n x 1) vector of producer prices in region i (i = o,c)

P = (2n x 1) vector of prices in both regions

ε^i = (2n x 1) vector of proportion of consumption expenditures in i on each industry's output in both regions (i = o,c)

t^{wi} = (n x 1) vector of average personal income tax rates in region i (i = o,c)

e^i = (n x 1) vector of surplus distribution coefficients in i (i = o,c)

X^i = (n x 1) vector of outputs in region i (i = o,c)

Y^i = (n x 1) vector of final demands in region i (i = o,c)

Y = (2n x 1) vector of final demands over both regions

X = (2n x 1) vector of total outputs over both regions

C^i = (2n x 1) vector of consumption expenditures by residents in i on industry outputs in both regions (i = o,c)

G = (2n x 1) vector of all government expenditures in both regions on all industries in o and c

M = (2n x 2n) matrix of government expenditure output multipliers

a^{ij} = (n x n) matrix of physical input-output coefficients from industries in i into industries in j (i,j = o,c)

l^i = (n x 1) vector of unit output labour requirements in region i (i = o,c)

k^i = (n x 1) vector of unit output capital requirements in region i (i = o,c)

h^i = (n x 1) vector of unit output import requirements in region i (i = o,c)

$\bar{w}^i$ = (n x 1) vector of wage rates in each industry in region i (i = o,c)

r^i = (n x 1) vector of rates of return to capital in region i (i = o,c)

t^i = (n x 1) vector of corporate tax rates in each industry in region i (i = o,c)

δ^i = (n x 1) vector of corporate tax shift parameters in i (i = o,c)

$\bar{r}^i$ = (n x 1) vector of net of tax returns to capital in i (i = o,c)

γ^i = (n x 1) vector of personal income tax shift parameters in i (i = o,c)

q^i = (n x 1) vector of consumer prices in region i (i = o,c)

t^{Fi} = (n x 1) vector of final demand taxes in region i (i = o,c)

t^{Ii} = (n x n) matrix of intermediate demand taxes in region i (i = o,c)

$\bar{a}^{ij}$ = (n x n) matrix of net of tax input-output coefficients from region i into region j (i,j = o,c)

L^i = (n x 1) vector of labour demands in region i (i = o,c)

ℓ^i = (n x 1) vector of share of labour in each industry in region i (i = o,c)

$\bar{L}^i$ = aggregate demand for labour in i (i = o,c)

B. Derivation of Interregional Input-Output Tables

This section gives the matrix operations used to combine the published Ontario and Canadian tables to give an interregional table.

1. Inter-industry Flows

(a) Remove foreign source imports from Ontario tables:

$$X^{\bar{c}o} = (I - \hat{\mu}^{fo})\, X^{ont} \tag{1}$$

(b) Remove imports from Canadian tables:

$$X^{\bar{c}\bar{c}} = (I - \hat{\mu}^{f\bar{c}})\, X^{can} \tag{2}$$

(c) Obtain $X^{\bar{c}\bar{c}}$ by:

$$X^{\bar{c}\bar{c}} = X^{\bar{c}\bar{c}} - X^{\bar{c}o} \tag{3}$$

(d) Obtain X^{oc} by:

$$X^{oc} = \hat{\mu}^{oc}\, X^{\bar{c}c} \tag{4}$$

(e) Obtain X^{cc} by:

$$X^{cc} = X^{\bar{c}c} - X^{oc} \tag{5}$$

(f) Obtain X^{co} by:

$$X^{co} = \hat{\mu} - X^{ont} \tag{6}$$

(g) Obtain X^{oo} by:

$$X^{oo} = \hat{\mu}^{oo}\, X^{ont} \tag{7}$$

2. Final Demand Matrix and Exports

(a) Elements of Y^{oo} obtained by:

$$Y^{oo} = (C^{oo}\ I^{oo}\ G^{oo}) = \hat{\mu}^{oo}\ Y^{ont} \qquad (8)$$

(b) Elements of Y^{co} obtained by:

$$Y^{co} = (C^{co}\ I^{co}\ G^{co}) = \hat{\mu}^{co}\ Y^{ont} \qquad (9)$$

(c) Elements of $Y^{\bar{c}\bar{c}}$ obtained by:

$$Y^{\bar{c}\bar{c}} = (C^{\bar{c}\bar{c}}\ I^{\bar{c}\bar{c}}\ G^{\bar{c}\bar{c}}) = (I - \hat{\mu}^{f\bar{c}})\ Y^{\bar{c}an} \qquad (10)$$

(d) Subtract the sum of (8) and (9) from (10) to give $Y^{\bar{c}c}$:

$$Y^{\bar{c}c} = Y^{\bar{c}\bar{c}} - Y^{co} - Y^{oo} \qquad (11)$$

(e) Obtain Y^{oc} by:

$$Y^{oc} = \hat{\mu}^{oc}\ Y^{\bar{c}c} \qquad (12)$$

(f) Obtain Y^{cc} by subtracting (12) from (11):

$$Y^{cc} = Y^{\bar{c}c} - Y^{oc} \qquad (13)$$

(g) E^{oc} obtained by summing elements of Y^{oc}:

$$E^{oc} = C^{oc} + I^{oc} + G^{oc} \qquad (14)$$

(h) E^{of} obtained by:

$$E^{oc} = E^{ont} - E^{oc} \qquad (15)$$

(i) E^{cf} obtained by:

$$E^{cf} = E^{can} - E^{of} \qquad (16)$$

3. Primary Inputs

(a) Primary inputs into Ontario industries (W^o, S^o, O^o) are as published.

(b) Primary inputs in rest of Canada obtained by:

$$V^c = \begin{vmatrix} W^c \\ S^c \\ O^c \end{vmatrix} = V^{can} - V^o \qquad (17)$$

4. Imports for Intermediate Use

These are obtained as residuals to balance the sum of rows and columns in the input-output tables.

(a) Total outputs in the two regions obtained by:

$$X_i^o = \sum_{j=1}^{n} (X_{ij}^{oo} + X_{ij}^{oc}) + Y_i^{oo} + Y_i^{oc} + E_i^{of} \qquad i=1,\ldots,n \qquad (18)$$

$$X_i^c = \sum_{j=1}^{n} (X_{ij}^{co} + X_{ij}^{cc}) + Y_i^{co} + Y_i^{cc} + E_i^{cf} \qquad i=1,\ldots,n \qquad (19)$$

(b) Since column and row totals must be equal:

$$M_i^o = X_i^o - \sum_j (X_{ji}^{oo} + X_{ji}^{co}) - W_i^o - S_i^o - O_i^o \qquad i=1,\ldots,n \qquad (20)$$

$$M_i^c = X_i^c - \sum_j (X_{ji}^{oc} + X_{ji}^{cc}) - W_i^c - S_i^c - O_i^c \qquad i=1,\ldots,n \qquad (21)$$

C. Derivation of Output Multipliers

In this section we present the algebraic derivations of output multipliers from government expenditures and the various tax rate changes.

1. Government Expenditure Output Multipliers

The aggregate consumption function in each region is:

$$E^i = c^i Y_d^i \qquad i = o,c. \qquad (1)$$

Since c^i is assumed constant, taking rates of change of (1) gives:

$$E^{i*} = Y_d^{i*} \qquad i = o,c. \qquad (2)$$

The demand functions have constant expenditure proportions on each good so:

$$P_j C_j^i = \varepsilon_j^i E^i \qquad i = o,c. \quad j = 1,\ldots,2n \qquad (3)$$

such that $\sum_j \varepsilon_j^i = 1$. Since P_j and ε_j^i are both constants in this case,

$$C_j^{i*} = E^{i*} = Y_d^{i*} \qquad i = o,c \quad j = 1,\ldots,2n \qquad (4)$$

The expression for disposable income is:

$$Y_d^i = \sum_j W_j^i (1-t_j^w) + \sum_j S_j^i e_j \qquad i = o,c \quad j = 1,\ldots,2n \qquad (5)$$

Note that we are neglecting personal income taxes paid on distributed profits. This is partly because data are difficult to obtain, but also a dividend tax credit is given to residents who receive dividends from Canadian corporations. While this does not eliminate tax payments on dividends entirely, we have assumed that the net taxes payable on distributed profits are small enough to be neglected.

To obtain Y_d^{i*}, we totally differentiate (5):

$$Y_d^{i*} = (1/Y_d^i) \left[\sum_j dW_j^i (1-t_j^w) + \sum_j dS_j^i e_j \right] \qquad i = o,c \quad j = 1,\ldots,2n$$

Since $W_j^i = w_j^i X_j$ and $S_j^i = s_j^i X_j$ (where w_j^i and s_j^i are the wage and surplus coefficients from the input-output tables),

$$Y_d^{i*} = (1/Y_d^i) \sum_j \left(w_j^i (1-t_j^w) + s_j^i e_j \right) dX_j \qquad \begin{array}{l} i = o,c. \\ j = 1,\ldots,2n \end{array} \qquad (6)$$

Rewriting (6) in vector notation and distinguishing between Ontario and the rest of Canada, we obtain:

$$Y_d^{o*} = Y_d^{o-1} (w^o.(1-t^w) + s^o.e)'dX \qquad (7)$$

$$Y_d^{c*} = Y_d^{c-1} (w^c.(1-t^w) + s^c.e)'dX \qquad (8)$$

The next step is to derive an expression for dX. Market clearing for industry j implies:

$$X_j^o = \sum_i A_{ji}^{oo} X_i^o + \sum_i A_{ji}^{oc} X_i^c + Y_j^{oo} + Y_j^{oc} \qquad i,j = 1,\ldots,n \qquad (9)$$

$$X_j^c = \sum_i A_{ji}^{co} X_i^o + \sum_i A_{ji}^{cc} X_i^c + Y_j^{co} + Y_j^{cc} \qquad i,j = 1,\ldots,n \qquad (10)$$

Writing (9) and (10) in matrix notation gives:

$$\begin{bmatrix} X^o \\ \hline X^c \end{bmatrix} = \begin{bmatrix} A^{oo} & A^{oc} \\ \hline A^{co} & A^{cc} \end{bmatrix} \begin{bmatrix} X^o \\ \hline X^c \end{bmatrix} + \begin{bmatrix} Y^o \\ \hline Y^c \end{bmatrix} \qquad (11)$$

Solving, we obtain,

$$X = (I-A)^{-1} Y$$

where A is the 2n x 2n matrix of intermediate flows both within and between regions and Y is the 2n x 1 vector of final demands. Totally differentiating (12) yields:

$$dX = (I-A)^{-1} dY$$

$$= (I-A)^{-1} (dC^o + dC^c + dG) \qquad (13)$$

Since C^o and C^c are endogenous and the remaining elements of final demand are fixed.

From (4), (7), and (8) we obtain expressions for dC^o and dC^c as follows:

$$dC^o = C^o Y_d^{o*} = \frac{C^o}{Y_d^o}(w^o.(1-t^w) + s^o.e)'dX \qquad (14)$$

$$dC^c = C^c Y_d^{c*} = \frac{C^c}{Y_d^c}(w^c.(1-t^w) + s^c.e)'dX \qquad (15)$$

where C^o and C^c are 2n x 1 vectors of consumption by residents of Ontario and the rest of Canada respectively.

Finally, we substitute (14) and (15) into (13) to give:

$$dX = (I-A)^{-1}\left[\frac{C^o}{Y_d^o}(w^o.(1-t^w) + s^o.e)'dX + \frac{C^c}{Y_d^c}(w^c.(1-t^w) + s^c.e)'dX + dG\right]$$

Solving for dX,

$$dX = \left[I-A-\frac{C^o}{Y_d^o}(w^o.(1-t^w) + s^o.e)' - \frac{C^c}{Y_d^c}(w^c.(1-t^w) + s^c.e)'\right]^{-1} dG$$

$$= M\ dG \qquad (16)$$

where the multiplier matrix is labelled M for future use. Equation (16) gives the changes in output by industry from a change in government expenditures on any industry.[1]

2. Output Multipliers From Corporate Tax Changes

The multiplier effects of corporate tax changes are more complicated than those of expenditure changes because of the fact that relative price changes result if the corporate tax is shifted forward. We derive first an expression for the price changes that result from corporate tax changes.

The producer prices of commodity i in regions o and c can be represented by:[2]

$$P_i^o = \sum_j a_{ji}^{oo} P_j^o + \sum_j a_{ji}^{co} P_j^c + \bar{w}_i^o l_i^o + r_i^o k_i^o + L_i^o \quad i = 1,\ldots,n \quad (17)$$

$$P_i^c = \sum_j a_{ji}^{oc} P_j^o + \sum_j a_{ji}^{cc} P_j^c + \bar{w}_i^c l_i^c + r_i^c k_i^c + L_i^c \quad i = 1,\ldots,n \quad (18)$$

By our assumptions a change in corporate tax rates may change the return to capital in the industries affected, but it will not affect wage rates or returns to capital in other industries. Thus a change in corporate tax in industry i will affect r_i. Totally differentiating (17) and (18) and converting to proportionate changes we obtain:

$$P_i^{o*} = \sum_j A_{ji}^{oo} P_j^{o*} + \sum_j A_{ji}^{co} P_j^{c*} + r_i^{o*} \; s_i^o \quad i = 1,\ldots,n \qquad (19)$$

$$P_i^{c*} = \sum_j A_{ji}^{oc} P_j^{o*} + \sum_j A_{ji}^{cc} P_j^{c*} + r_i^{c*} \; s_i^c \quad i = 1,\ldots,n \qquad (20)$$

where A_{ji} are the value input-output coefficients as before and s_i^o, s_i^c are the surplus coefficients for Ontario and the rest of Canada.[3]

Putting (19) and (20) into matrix notation and solving, we obtain:

$$\begin{bmatrix} P^{o*} \\ \hline P^{c*} \end{bmatrix} = \left[I - \left[\begin{array}{c|c} A^{oo} & A^{oc} \\ \hline A^{co} & A^{cc} \end{array} \right]' \right]^{-1} \begin{bmatrix} r^{o*} . s^o \\ \hline r^{c*} . s^c \end{bmatrix} \qquad (21)$$

or,

$$P^* = (I-A')^{-1} r^* . s \qquad (22)$$

These are 2n equations in 2n unknowns, P^*.

As yet, we have no expression for r^*, the vector of changes in gross rates of return to capital. A typical element, r_j^*, will depend upon the change in corporate tax rate in that industry, t_j^*, and the extent to which the tax is shifted. We develop a parameter, δ_j^i, called a shift parameter as follows. When $\delta_j^i = 1$, the tax increase in region i on industry j is completely shifted in a higher gross return to capital leaving the net return unchanged. When $\delta_j^i = 0$, the gross return is unchanged and the tax is completely absorbed in the net return. In between, the tax is partly shifted and partly absorbed. Analytically, denoting the net return by $\bar{r}_j^i$, and assuming t_j^i is levied on the gross return, r_j^i, δ_j^i is defined by:

$$dr_j^i = \delta_j^i \, dt_j^i \, r_j^i$$

$$d\bar{r}_j^i = (\delta_j^i - 1) \, dt_j^i \, r_j^i$$

Therefore,

$$d\bar{r}_j^i = \frac{\delta_j^i - 1}{\delta_j^i} \, dr_j^i \qquad (23)$$

We also know from the definition of t_j^i that:

$$\bar{r}_j^i = r_j^i(1-t_j^i)$$

Differentiating,

$$d\bar{r}_j^i = dr_j^i(1-t_j^i) - r_j^i dt_j^i$$

Substituting in (23) and solving for r_j^{i*},

$$r_j^{i*} = \frac{\delta_j^i \, t_j^i}{1-\delta_j^i t_j^i} \, t_j^{i*} \qquad \begin{array}{l} j = 1,\ldots,n \\ i = o,c \end{array} \qquad (24)$$

Substitution of (24) into (22) yields the equation relating changes in corporate tax rates by industry to changes in price by industry:

$$P^* = (I-A')^{-1}\left(\frac{\delta . t}{1-\delta . t}\right).t^*.s \qquad (25)$$

where P^*, δ, t, t^*, and s are all $2n \times 1$ vectors. These price changes must be taken into account in computing consumption expenditures by commodity.[4]

As before, aggregate consumption is given by (1) and consumption by commodity by (3). Converting (3) to rates of change, we now obtain:[5]

$$C_j^{i*} = Y_d^{i*} - P_j^{i*} \qquad \begin{array}{l} i = o,c \\ j = 1,\ldots,n \end{array} \qquad (26)$$

Therefore, the changes in consumption in Ontario and the rest of Canada (in vector notation) are:

$$dC^o = c^o Y_d^{o*} - c^o.P^* \qquad (27)$$

$$dC^c = c^c Y_d^{c*} - c^c.P^* \qquad (28)$$

To derive an expression for Y_d^{i*}, we totally differentiate (5) to give:[6]

$$Y_d^{i*} = (1/Y_d^i)\left[\sum_j (w_j^i(1-t_j^w) + s_j^i e_j)dX_j + \sum_j ds_j^i e_j X_j\right] \qquad (29)$$

where now we must take into consideration induced changes in surplus due to the corporate tax. It is important to note here that we are treating the labour coefficients w_j^i as constant and valued at the pre-tax change value.

The same is true of all coefficients in the I-O Table except for the s_j^i which change due to the tax. The rationale for neglecting the changes in coefficients arising from the relative price changes is that when we use the I-O matrices to show the influence of changes in final demand on outputs (and labour demand below), the final demand changes we use, dC_j^i, have had price changes removed. In effect, dC_j^i is the change in demand valued at the old prices which can be thought of as being normalized to unity. Therefore, we must use the old coefficients which do not incorporate price changes in them.

To use (29), we need an expression for ds_j^i. These show the change in surplus coefficients net of the tax change as a result of the industry having to absorb part of the tax change. Since $s_j^{i*} = \bar{r}_j^{i*}$, and $\bar{r}_j^i = r_j^i(1-t_j)$, taking the rate of change of the latter gives:

$$s_j^{i*} = \bar{r}_j^{i*} = r_j^{i*} - \frac{t_j^i}{1-t_j^i} t_j^* \qquad (30)$$

Using (24), this becomes:

$$s_j^{i*} = \left[\frac{\delta_j^i t_j^i}{1-\delta_j^i t_j^i} - \frac{t_j^i}{1-t_j^i} \right] t_j^{i*} \qquad (31)$$

Obtaining an expression for ds_j^i from (31), substituting into (29) and converting to matrix notation, we get:

$$Y_d^{o*} = Y_d^{o-1} \left[(w^o.(1-t^w) + s^o.e)' \, dX + \left[\frac{\delta.t}{1-\delta.t} - \frac{t}{1-t} \right] .t^*.s^o.eX \right] \qquad (32)$$

$$Y_d^{c*} = Y_d^{c-1} \left[(w^c.(1-t^w) + s^c.e)' \, d\dot{X} + \left(\frac{\delta.t}{1-\delta.t} - \frac{t}{1-t} \right) .t^*.s^c.eX \right] \qquad (33)$$

As before, from differentiating (12), we get:

$$dX = (I-A)^{-1}(dC^{o} + dC^{c}) \qquad (34)$$

Substituting (32) and (33) into (27) and (28) and the resultant expressions for dC^{o} and dC^{c} into (34), we obtain:

$$dX = (I-A)^{-1}\Bigg[\frac{C^{o}}{Y_d^{o}}\Big[(w^{o}.(1-t^{w}) + s^{o}.e)'dX + \Big[\frac{\delta.t}{1-\delta.t} - \frac{t}{1-t}\Big].t^{*}.s^{o}.eX\Big] - C^{o}.P^{*} + \frac{C^{c}}{Y_d^{c}}\Big[(w^{c}.(1-t^{w}) + s^{c}.e)'dX + \Big[\frac{\delta.t}{1-\delta.t} - \frac{t}{1-t}\Big].t^{*}.s^{c}.eX\Big] - C^{c}.P^{*}\Bigg] \qquad (35)$$

Solving (35) for dX yields:

$$dX = M\Bigg[\frac{C^{o}}{Y_d^{o}}\Big[\frac{\delta.t}{1-\delta t} - \frac{t}{1-t}\Big].t^{*}.s^{o}.eX + \frac{C^{c}}{Y_d^{c}}\Big[\frac{\delta.t}{1-\delta.t} - \frac{t}{1-t}\Big].t^{*}.s^{c}.eX - (C^{o} + C^{c}).P^{*}\Bigg] \qquad (36)$$

where M is the multiplier matrix as in (16) above, and P^{*} is the 2n x 1 vector of price changes from (25).

Using (36), we can derive output multipliers for changes in corporate tax rates by industry, or industries, according to any shifting assumptions desired.

Note one complication that arises in the two region context. Federal corporate tax rates apply to both Ontario and the rest of Canada. When looking at changes in federal corporate tax, we therefore look at that tax as applied to all 2n industries (n in each region). However, when assessing the impact of Ontario corporate tax changes, we need only consider the n industries in Ontario. Thus t_j^{c} for the n industries in the rest of Canada are identically zero.

3. Output Multipliers From Personal Income Tax Changes

The derivation of multipliers for personal income tax changes is exactly analogous to that of corporate tax changes. By our assumptions, income tax changes will only affect wage coefficients and no other coefficients. Therefore, instead of (22), the price change equation becomes:

$$P^{*} = (I-A)^{-1}\,\bar{w}^{*}.w \qquad (37)$$

The proportionate change in the wage rate, $\bar{w}^{*}$, is derived as before assuming different "shift parameters". These are labelled γ_j^i. Proceeding as in the corporate tax case, the proportionate changes in wage rates are:

$$\bar{w}_j^{i*} = \frac{\gamma_j^i \; t_j^{wi}}{1-\gamma_j^i t_j^{wi}}\, t_j^{wi*} \qquad i = o,c \quad j = 1,\ldots,n \qquad (38)$$

Substituting (38) into (37) yields:

$$P^{*} = (I-A')^{-1}\left[\frac{\gamma . t^{w}}{1-\gamma . t^{w}}\right] . t^{w*} .w \qquad (39)$$

This is the pricing change equation for the personal income tax case.[7]

Consumption change equations (27) and (28) remain as before. However, we now obtain a different expression for the proportionate change in disposable income:

$$Y_d^{i*} = (1/Y_d^i)\left[\sum_j (w_j^i(1-t_j^{w}) + s_j^i e_j)\,dX_j + \sum_j dw_j^i(1-t_j^{w})X_j + \sum_j w_j^i X_j^i t_j^{wi} t_j^{wi*}\right] \qquad (40)$$

Also, as before, an expression corresponding to (31) may be derived for w_j^{i*} :

$$w_j^{i*} = \left[\frac{\gamma_j^i t_j^{wi}}{1-\gamma_j^i t_j^{wi}} - \frac{t_j^{wi}}{1-t_j^{wi}} \right] t_j^{wi*} \qquad (41)$$

Substitution of dw_j^i from (41) into (40) gives:

$$Y_d^{o*} = Y_d^{o-1} \left[(w^o.(1-t^w)+s^o.e)'dX + \left[\frac{\gamma.t^w}{1-\gamma.t^w} - \frac{t^w}{1-t^w} \right] .t^{w*} .w^0.(1-t^w).X - w^o .X.t^w.t^{w*} \right] \qquad (42)$$

$$Y_d^{c*} = Y_d^{c-1} \left[(w^c.(1-t^w)+s^c.e)'dX + \left[\frac{\gamma.t^w}{1-\gamma.t^w} - \frac{t^w}{1-t^w} \right] .t^{w*}.w^c.(1-t^w).X - w^c.X.t^w.t^{w*} \right] \qquad (43)$$

The expression for dX, (34), remains as before. Substituting (42) and (43) into (27) and (28) and the results into (34), we obtain:

$$dX = (I-A)^{-1} \left[\frac{C^o}{Y_d^o} \left[(w^o.(1-t^w)+s^o.e)'dX + \left[\frac{\gamma.t^w}{1-\gamma.t^w} - \frac{t^w}{1-t^w} \right] .t^{w*}.w^o.(1-t^w)X - w^o.X.t^w.t^{w*} \right] -C^o.P^* + \frac{C^c}{Y_d^c} \left[(w^c.(1-t^w)+s^c.e)'dX + \left[\frac{\gamma.t^w}{1-\gamma.t^w} - \frac{t^w}{1-t^w} \right] .t^{w*}.w^c.(1-t^w) X - w^c.X.t^w.t^{w*} \right] - C^c.P^* \right] \qquad (44)$$

Solving (44) for dX:

$$dX = M \left[\frac{C^o}{Y_d^o} \left[\frac{\gamma.t^w}{1-\gamma.t^w} - \frac{t^w}{1-t^w} \right] .t^{w*}.w^o.(1-t^w)X + \frac{C^c}{Y_d^c} \left[\frac{\gamma.t^w}{1-\gamma.t^w} - \frac{t^w}{1-t^w} \right] .t^{w*}.w^o.(1-t^w)X - (C^o + C^c).P^* \right.$$

$$- X.t^{w}.t^{w*}.\left[\frac{C^{o}}{Y_{d}^{o}}.w^{o} + \frac{C^{c}}{Y_{d}^{c}}.w^{c}\right]\Bigg] \qquad (45)$$

where M is the multiplier matrix again and P^* is obtained from (39).

Multipliers can be calculated for personal income tax changes by the Federal government which affect t_j^{wi} in both Ontario and the rest of Canada, or, by the Ontario government which affect all t_j^{wo} but not t_j^{wc}.

4. Output Changes From Changes in Commodity Taxes on Final Demand

Tax changes on final demand sales are assumed to operate by raising prices to consumers. By our previous assumptions on the fixity of factor prices, the expressions for producer prices, (17) and (18), indicate that producer prices remain unchanged.[8] Changes in consumers' prices are given by:

$$q_j^i = P_j^i(1 + t_j^{fi}) \qquad (46)$$

where q_j^i are consumer prices and t_j^{fi} are final demand taxes on good j in region i. Taking rates of change of (46), with fixed P_j^i, we obtain the following expression for consumer price changes:

$$q_j^{i*} = t_j^{fi*}\left[\frac{t_j^{fi}P_j^i}{q_j^i}\right] = t_j^{fi*}\left[\frac{t_j^{fi}}{1+t_j^{fi}}\right]$$

or, in vector notation,[9]

$$q^* = t^{f*}.\left[\frac{t^f}{1+t^f}\right] \qquad (47)$$

Since we must now distinguish consumer from producer prices[10] the demand equations are:

$$q_j^i C_j^i = \varepsilon_j^i E^i \qquad (48)$$

Taking rates of change and proceeding as before, the rates of change of consumption become

$$C_j^{o*} = Y_d^{o*} - q_j^{o*} \tag{49}$$

$$C_j^{c*} = Y_d^{c*} - q_j^{c*} \tag{50}$$

To get expressions for Y_d^{o*} and Y_d^{c*}, we note that all w_j^i and s_j^i are constants so that (29) reduces to (in vector notation):

$$Y_d^{o*} = (Y_d^o)^{-1}(w^o.(1-t^w) + s^o.e)'dX \tag{51}$$

$$Y_d^{c*} = (Y_d^c)^{-1}(w^c.(1-t^w) + s^c.e)'dX \tag{52}$$

The expression for dX is still (34). We may substitute (51) and (52) into (49) and (50) and substitute the resultant expressions for dC^o and dC^c into (34) to give:

$$dX = (I-A)^{-1}\left[\frac{C^0}{Y_d^o}(w^o.(1-t^w) + s^o.e)'dX - C^o.q^* + \frac{C^c}{Y_d^c}(w^c.(1-t^w) + s^c.e)'dX - C^c.q^*\right] \tag{53}$$

Solving (53) for dX yields:

$$dX = -M(C^o + C^c).q^* \tag{54}$$

where M is once again our multiplier matrix from (16) and q^* is obtained from (47).

Output multipliers may be obtained for changes in final demand tax rates by the Federal government (affecting all q_j^i); or, to final demand rates by the Ontario government (affecting q_j^o only).

5. Output Changes From Changes in Commodity Taxes on Intermediate Demand

Tax changes on intermediate purchases operate by increasing producer prices via increases in the prices of purchased inputs. Pricing equations (18) and (19) may be rewritten to incorporate intermediate taxes as follows:

$$P_i^o = \sum_j \bar{a}_{ji}^{oo}(1+t_{ji}^o)P_j^o + \sum_j \bar{a}_{ji}^{co}(1+t_{ji}^c)P_j^c + \bar{w}_i^o \ell_i^o + r_i^o k_i^o + M_i^o \qquad (55)$$

$$P_i^c = \sum_j \bar{a}_{ji}^{oc}(1+t_{ji}^o)P_j^o + \sum_j \bar{a}_{ji}^{cc}(1+t_{ji}^c)P_j^c + \bar{w}_i^c \ell_i^c + r_i^c k_i^c + M_i^c \qquad (56)$$

where $\bar{a}_{ji}^{oo}$ is the net of tax input-output coefficient, and t_{ji}^o is the _ad valorem_ rate of tax paid in Ontario on sales from industry j to i.

Tax changes are assumed not to change $\bar{w}_i$, r_i, and M_i^o so the total differentials of (55) and (56) are:

$$dP_i^o = \sum_j \bar{a}_{ji}^{oo}(1+t_{ji}^o)dP_j^o + \sum_j \bar{a}_{ji}^{co}(1+t_{ji}^c)dP_j^c + \sum_{ij}\sum \bar{a}_{ji}^{oo}P_j^o dt_{ji}^o + \sum_{ij}\sum \bar{a}_{ji}^{co}P_j^c dt_{ji}^c \qquad (57)$$

$$dP_i^c = \sum_j \bar{a}_{ji}^{oc}(1+t_{ji}^o)dP_j^o + \sum_j \bar{a}_{ji}^{cc}(1+t_{ji}^c)dP_j^c + \sum_{ij}\sum \bar{a}_{ji}^{oc}P_j^o dt_{ji}^o + \sum_{ij}\sum \bar{a}_{ji}^{cc}P_j^c dt_{ji}^c \qquad (58)$$

Converting (57) and (58) to rates of change gives:

$$P_i^{o*} = \sum_j A_{ji}^{oo} P_j^{o*} + \sum_j A_{ji}^{co} P_j^{c*} + AT^o \qquad (59)$$

$$P_i^{c*} = \sum_j A_{ji}^{oc} P_j^{o*} + \sum_j A_{ji}^{cc} P_j^{c*} + AT^c \qquad (60)$$

where, for example, $A_{ji}^{oo} = \bar{a}_{ji}^{oo}(1+t_{ji}^{o})P_j^o/P_i^o$

and $$AT^o = \sum_j \sum_i \left[A_{ji}^{oo} \left[\frac{t_{ji}^o}{1+t_{ji}^o} \right] t_{ji}^{o*} + A_{ji}^{co} \left[\frac{t_{ji}^c}{1+t_{ji}^c} \right] t_{ji}^{c*} \right]$$

Writing (59) and (60) in matrix form and solving for proportionate price changes yields:

$$P^* = (I-A')^{-1}\ ATV \qquad (61)$$

where ATV is a 2n x 1 vector whose first n elements are AT^o and whose second n elements are AT^c.

Proceeding exactly as before, we find the matrix expression for dX to be:

$$dX = -M(C^o + C^c)\cdot P^*$$

$$= -M(C^o + C^c)\cdot(I-A')^{-1}ATV \qquad (62)$$

where again M is the multiplier matrix from (16).

Using (62) we may obtain the changes in output by industry in each region from changing any set of intermediate taxes. Once again, Ontario tax changes will affect only Ontario industries whereas federal tax changes affect both regions.

D. Changes in Labour Demand Arising From Changes in Output

The preceding sections have derived a series of expressions for the vector dX from changing corporate, personal income, and commodity tax rates either in Ontario or in both regions. From these changes in gross outputs, we may derive expressions for the change in labour demand by industry, by region, and for all of Canada.

Assuming that all types of labour are used in fixed proportions in each industry,[11] the proportionate change in labour demand will equal the proportionate change in wage payments. Since wage payments in industry j in region i are given by $W_j^i = w_j^i X_j^i$, then

$$W_j^{o*} = w_j^o \frac{dX_j^o}{W_j^o} = L_j^{o*} \tag{63}$$

and

$$W_j^{c*} = w_j^c \frac{dX_j^c}{W_j^c} = L_j^{c*} \tag{64}$$

From (63) and (64) we can calculate the proportionate change in labour demand by industry from the changes in gross outputs for each tax or expenditure change.

The aggregate demands for labour in the two regions are given by:

$$L^o = \sum_j L_j^o \; ; \; L^c = \sum_j L_j^c$$

Taking rates of change of these equations, we get:

$$L^{o*} = \sum_j \ell_j^o L_j^{o*} = \sum_j \ell_j^o w_j^o \frac{dX_j^o}{W_j^o} \tag{65}$$

$$L^{c*} = \sum_j \ell_j^c L_j^{c*} = \sum_j \ell_j^c w_j^c \frac{dX_j^o}{W_j^c} \tag{66}$$

where ℓ_j^i is the share of the private sector's use of labour in region i employed in industry j.

Similarly, the aggregate demand for labour in the country as a whole is given by $L = L^o + L^c$. In rate of change terms, this becomes:

$$L^* = \ell^o L^{o*} + \ell^c L^{c*} \qquad (67)$$

where ℓ^o and ℓ^c are the shares of the Canadian labour force employed in Ontario and the rest of Canada.

END NOTES

1 This formula and all others in this chapter are derived for differential changes only. In our computations we, of course, consider discrete changes. The differential formulae are therefore only approximations.

2 The convention we are following is to represent physical input-output coefficients by a_{ij}. Value coefficients are A_{ij} (= X_{ij}/X_j).

Since X's are in value terms, $a_{ij} = P_j X_{ij}/P_i X_j$.

3 That is, $s_i^o = k_i^o \; r_i^o/P_i^o$; similarly for s_i^c.

4 Notice that equations (24) and (25) would not be satisfactory if the initial tax rate were zero. In this case, t^{i*} is not defined. To overcome this, equation (24) could be written in the alternate form:

$$r_j^{i*} = \frac{\delta_j . dt_j^i}{1-\delta_j^i t_j^i} = \delta_j^i dt_j^i$$

Then, (25) would become:

$$P^* = (I-A')^{-1} \; \delta.dt.s$$

The model would then proceed as before. In our computation no new taxes were imposed when none existed before so that this formulation never had to be used. This proviso holds for all the other types of tax changes considered below.

5 We need not distinguish between consumer and producer prices here. Even though they differ, their rates of change will be the same as long as the tax rate on final demand is fixed. Consumer prices and producer prices will only change at different rates when the tax rate on final demand changes. $q_i = P_i(1+t_i)$

Therefore,

$$q_i^* = P_i^* + t_i^* \frac{P_i}{q_i}$$

6 In deriving (29), we have used $S_j^i = s_j^i X_j$ so that $dS_j^i = s_j^i dX_j + ds_j^i X_j$.

7 As in Footnote 4, this formulation must be amended if t^{wi} is zero for any i or j. Equation (38) would read:

$$\bar{w}^{i*} = \gamma_j^i dt_j^{wi}$$

8 By assuming fixity of factor prices in the face of increases in goods prices but allowing for the possibility of some shifting of personal income taxes forward in higher wages, we are implying that some "tax illusion" may be present. A more elaborate treatment might allow for some reaction of wage payments to goods price increases caused by tax increases.

9 As earlier, if taxes are imposed where t_j^{fi} is zero, (47) would have to be amended to read:

$$q_j^{i*} = dt_j^{fi}$$

10 See Footnote 5.

11 In addition, as mentioned earlier, we are assuming that marginal and average wage coefficients do not differ. To the extent that they do in the short run, the labour demand changes will be incorrectly specified (if marginal wage coefficients are less than average, labour demand changes will be overstated). If, however, marginal and average wage coefficients differ by the same amount over all industries, the relative magnitudes of labour multipliers calculated for various tax changes will not be affected.

Technical Appendix to Chapter 8

A. Simple Income and Employment Multipliers

A.A. Kubursi

The basic model is a static, open Leontief system with average impact coefficients equal to their marginal values and with no possibility of substitution among the processes of production. Furthermore, unless otherwise indicated, it is assumed that changes in any one component of final demand have no effect on the remaining components. Consider now a mathematical statement of the model.

In matrix-vector notation, the following accounting balance equation must hold (that is, equality of total production satisfying intermediate plus final demand, exclusive of imports):

(1) $x = Ax + Cc + Ff + Gg - m$

where

- x is an $n \times 1$ vector, representing the value of output for each of the n industries in current dollars;
- A is an $n \times n$ matrix of fixed technology coefficients;
- C is an $n \times 1$ vector of consumption coefficients;
- c is a scalar, representing the value of consumption in the base year;
- F is an $n \times s$ matrix of final demand coefficients, including investment, inventory changes and exports;
- f is an $s \times 1$ vector of dollar value of other final demand by source, in the base year;
- G is an $n \times p$ matrix of government expenditure coefficients, whose $(j,k)^{th}$ element is dollars of purchases from industry j per dollar spent on the k^{th} expenditure program;
- g is a $p \times 1$ vector of values of expenditures by program in the base year;
- m is an $n \times 1$ vector representing the value of imports in the base year for each of the n industries.

From (1) and assuming that imports are proportional to intermediate and final demand, a functional relationship between output and final demand may be obtained:

(2) $x = (I - (I - \hat{u})A)^{-1} (I - \hat{u}) (Gg + Cc + Ff)$

where

I is an n x n identify matrix, and

$\hat{u}$ is an n x n diagonal matrix whose diagonal entries are import requirements per unit of gross supply (x+m).

The total and "employment" incomes generated in the reference year are defined by the following system of equations:

(3) $y = Bx + Hg + Dc + Ef$

where

y is a 2r x 1 matrix of total income and employment income in each of the r regions;

B is a 2r x n matrix of regional income and employment coefficients;

H, D, and E are direct primary input coefficients of appropriate order associated with government, consumption and other final demand.

Substituting for x into (3) yields the following relationship between income and "employment" and final demand:

(4) $y = B(I - (I - \hat{u})A)^{-1} (I - \hat{u}) (Gg + Cc + Ff) + Hg + Dc + Ef$

Thus, assuming a change only in government expenditures by type of program (Δg), the result is

(5) $\Delta y = B(I - (I - \hat{u})A)^{-1} (I - \hat{u}) (G\hat{\Delta g}) + (H\hat{\Delta g})$ where

Δy is now a matrix (2r x p) where r is the number of regions and p is the number of programs, and

$\hat{\Delta g}$ is a diagonal matrix (p x p) whose diagonal entries are the p changes in government expenditure programs.

B. Income and Employment Multipliers (Induced Effects Included)

In Section A, the multipliers were derived subject to the assumption that the final demand vector is constant and given, the only changes permitted being those at the intermediate level in response to disturbances introduced in the final demand bill of goods and services. This is not very realistic, for changes in output result in changes in income which result in changes in final demand, particularly in consumption, which economists have long verified to be very sensitive to variations in income.

Relating consumption to income involves adjusting the input-output system in equation (1) in the following manner. First, Disposable Income is defined:

$$(6)\quad \eta = h'x + \alpha - t(h'x + \alpha)$$

$$(6^{a})\quad -h'x + \frac{\eta}{1-t} = \alpha$$

where h' is a row vector of value added per unit of output of each industry, t is the income tax rate, and α represents income payments to households under final demand. Rewriting equation (2) to integrate the household sector with the other productive sectors yields (7):

$$(7)\quad \begin{bmatrix} I-(I-\hat{u})A & -(I-\hat{u})Cc/\eta \\ \hline -h' & \frac{1}{1-t} \end{bmatrix} \begin{bmatrix} x \\ \hline \eta \end{bmatrix} = \begin{bmatrix} (I-\hat{u})\ (Gg + Ff) \\ \hline \alpha \end{bmatrix}$$

In a more compact form, system (7) can be expressed as follows:[8]

$$(8)\quad Q\left(\frac{x}{\eta}\right) = \begin{bmatrix} (I-\hat{u})\ (Gg + Ff) \\ \hline \alpha \end{bmatrix}$$

The solution of (8) is given in (9)

$$(9)\quad \left(\frac{x}{\eta}\right) = Q^{-1}\begin{bmatrix} (I-\hat{u})\ (Gg + Ff) \\ \hline \alpha \end{bmatrix}$$

Now, define $\bar{Q}$ as a matrix formed by deleting the last row and column of (Q^{-1}). This new matrix can now be used instead of $(I-(i-\hat{u})A)^{-1}$ in all the calculations. When the matrix $\bar{Q}$ is used, the results reflect not only the direct and indirect output effects in response to a unit change in government expenditure, but also the induced effects because of the incorporation of consumption and income in (9).

Thus,

$$(10) \quad \overline{\Delta y} = B\ \bar{Q}\ (I-\hat{u})\ G\hat{\Delta}g + H\hat{\Delta}g$$

denotes the direct, indirect and induced income in each region generated in response to a dollar change in each of the expenditure programs of government. The short-run nature of this equation should be emphasized since investment is kept constant.

C. Employment Multipliers in Man-Year Units

The translation of sectoral employment income into sectoral man-years or man-hours equivalents requires some additional information. Two alternatives were adopted in this study to generate employment effects in physical units. The first approach involved the estimation of labour income (cost) needed to sustain a given level of final demand and then division of the derived total for each sector by its sectoral wage rate. Thus, the level of employment associated with government expenditure program j is

$$(11) \quad \sum_{ij}\sum \frac{w_i\ A_{ij}\ (1-\hat{u}_j)\ G_{jk}\ g_k}{s_i} + \theta_k g_k \qquad (k = 1,\ldots,p)$$

where the A_{ij} are the elements of inverse matrix $(I - (I-\hat{u})A)^{-1}$, s_i are the sectoral wage rates, and θ_k represents the direct employment figures associated with program k.

When the macroeconomic effects of consumption are taken into account, equation (11) takes the following form:

$$(12)\quad \sum_{i}\sum_{j} \frac{w_i \bar{Q}_{ij} (1-\hat{u}_j) G_{jk} g_k}{s_i} + \theta_k g_k \qquad (k = 1,\ldots,p)$$

In matrix vector notation, equations (11) and (12) are represented by relationships (13) and (14) respectively:

$$(13)\quad w'(\hat{S})^{-1} (I - (I-\hat{u})A)^{-1} (I-\hat{u})\ G\hat{g} + \theta'\hat{g}, \quad \text{and}$$

$$(14)\quad (w'(\hat{S})^{-1} \bar{Q}(I-\hat{u})\ G + \theta')\hat{g}.$$

The results in (13) will be nine figures representing direct and indirect employment in the province as whole associated with each expenditure program. The results derived from applying system (14) will assume the same format as that of (13), but will include the induced effects too.

The allocation of employment over the sub-regions of Ontario is performed by adjusting equations (13) and (14). The adjustment of (13) is simple and is

$$(15)\quad W(\hat{S})^{-1} (I - (I-\hat{u})A)^{-1} (I-\hat{u})\ G\hat{g} + K\hat{g}.$$

For the induced effects, (14) becomes

$$(16)\quad W(\hat{S})^{-1} \bar{Q}(I-\hat{u})\ G\hat{g} + K\hat{g}$$

where W is a matrix of direct labour requirements by region and industry, and K is also a matrix of labour requirements by region directly employed by government.

The general proposition underlying the equations in (11) - (16) is that sectoral wage rates are the same in every region for the same industry. Since this is not true, the diagonal matrix $(\hat{S})$ must be replaced by a matrix

$\bar{S}$ whose typical entry ($\bar{S}_{ij}$) will be the inverse of the wage rate for sector i in region j. Thus, equations (15) and (16) become

(17) $W(I - (I-\hat{u})A)^{-1} (I-\hat{u})\ \bar{S}\ G\hat{g} + K\hat{g}$ and

(18) $W\ \bar{Q}(I-\hat{u})\ \bar{S}\ G\hat{g} + K\hat{g}$

The basic advantage of the approach discussed in equations (11) - (18) is its great flexibility. It is now possible to assess the employment impact of a given expenditure program on every region allowing for sectoral wage differences. The major disadvantage of this approach, however, is the constancy of the sectoral wage rates and the direct labour requirements. To overcome this, another approach is presented.

The alternative approach deals directly with employees per unit of output. A linear relation is hypothesized to hold between employment in any given sector on the one hand and output of the sector, time and an error term on the other hand:

(19) $L_{it} = \gamma_i + \Phi_i X_{it} + B_{it} + U_{it}.$

The general assumptions of Ordinary Least Squares (OLS) are made:

$EU_t = 0$

$E(U_t' U_\theta) = \sigma^2,$

subject to which the parameters γ_i, Φ_i and B_i are estimated. The impact on employment in a given sector that results from a change in any given expenditure program is then

(20) $L_{ipt} = \hat{\gamma}_i + \hat{\Phi}_i(\sum_j A_{ij}\ G_{jp}\ \Delta g_p) + \hat{B}_i t$

Obviously the second approach provides more information than the first one. The results can now be visualized by industry, program and time simultaneously.

Technical Appendix to Chapter 9

A. The Optimum Mix of Government Expenditures

A.A. Kubursi

The basic model here is a static non-stochastic linear programming system. The analysis is conducted in terms of a Kuhn-Tucker format to serve the purpose of providing an approach that is more general than the linear programme; if adjustments are required, they could be easily incorporated.

In the first model government is hypothesized to seek the maximization of income of the province:

(1) Max $h'x$

subject to

$$Ax + Gg + f^* \leq x$$
$$i'g \leq \bar{g}$$
$$x \geq o, \; g \geq o$$

where

h' is a row vector of value added coefficients by industry;

x is a column vector of gross output by industry,

A is the technology matrix;

G is the government expenditure coefficients matrix organized by industry and program;

$\bar{g}$ is a scalar representing the government budget ceiling;

f^* is a column vector of other final demands;

i' is an $1 \times n$ row vector whose components are all ones;

To solve the problem we introduce Lagrangean multipliers $\lambda_1,\ldots,\lambda_n$, μ, $\phi_1,\ldots,\phi_n$, ϕ and $\gamma_1,\ldots,\gamma_n$, to form the Lagrangean expression.

(3) $L = h'x + \lambda'(x - Ax - Gg - f^*) + \mu(\bar{g}-i'g) + \phi'x + \gamma'g$

Assuming that h'x is a quasi concave function defined over a convex subset of the Euclidean Space and that the constraint set is convex. Then (x^o, g^o) represent a maximum of h'x subject to the constraints in (2), if and only if the following conditions are satisfied.

Condition 1

(4) $\frac{\partial L}{\partial x} = o = h' + \lambda' (I-A) + \phi' = o$

Condition 2

(5) $\frac{\partial L}{\partial g} = 0 = -\lambda' G - \mu i' + \gamma' = 0$

These two conditions are necessary and sufficient to designate the optimal program g^o and the optimal production bill x^o. This is easily demonstrated by reference to Khun-Tucker and Arrow-Enthovan theorems.

The specific implications of conditions 1 and 2 are the following:

From the first condition and Khun-Tucker theorem it follows that,

(6) $h' + \lambda'(I-A) + \phi' = 0$

and that if $x^o > 0$ then $\phi' = 0$ and $h' = -\lambda'(I-A)$,

or $h'(I-A)^{-1} = -\lambda'$

Alternatively,

(7) if $x^o = 0$ then $\phi' > 0$ and $h'(I-A)^{-1} \leq -\lambda'$

Furthermore, given the second condition

(8) $-\lambda' G - \mu i' + \gamma' = 0$

then if $g^o > 0$, $\gamma' = 0$ and $h'(I-A)^{-1} G = \mu'$, or $\lambda' G = \mu'$.

However, if $g^o = 0$, $\gamma' > 0$ and $h'(I-A)^{-1} G \leq \mu'$, or

(9) $\lambda' G \leq \mu'$.

Therefore, it is possible to interpret the μ's as the partial multipliers which will prevail when government expenditure is concentrated in industry j in a system with all outputs flexible. Moreover, as $g^o = 0$, if $\lambda_j G^j < \mu_j$, efficiency requires that government expenditures should be allocated over programs in such a way that programs absorb the largest industrial outputs from industries whose partial multipliers are greatest. Furthermore, it is also true that all the x_i^o are positive since all the g_i^o are non-negative and the f_i^* are positive.

The model discussed above can easily be regionalized. Vector h may be extended into a matrix whose components are regions by industries. The efficiency criterion of the budget involves allocating the budget over programs in a manner that corresponds with the ranks of the industrial multipliers in the various regions, i.e., devoting the largest portion of the budget to the programs that absorb industrial outputs from industries whose partial multipliers are greatest in the desired region.

The linear programming format of the first would now assume the following nature:

(10) $\text{Max } h_j'x \qquad (j = 1,\dots,r)$

s.t.

$Ax + f^* + Gg \leq x$

(11) $i'g \leq \bar{g}$

$g \geq 0, \; x \geq 0$

B. The Government Budget: A Portfolio Selection Problem

The regional characteristics of our optimizing problems are perhaps too simple to capture the complex reality of regional economic policy. A major objective of regional economic policy often centers around reducing regional income disparities. To introduce this significant objective into the models discussed above, a major rehabilitation process is required. An interesting and perhaps a more flexible approach may be constructed along the portfolio selection models of Markowitz. These belong primarily to the set of quadratic programming problems. The objective function is hypothesized to involve allocating the budget over programs in proportions that insure the minimization of the variance of regional per capita incomes. More precisely, corresponding to each budget proportion (g_k) there is an expected provincial income (r_k). This provincial income is allocated over regions according to equation (11):

$$(11)\quad r_{ik} = \sum_{jp}\sum w_{ij} B_{jp} G_{pk} G_k$$

where w_{ij} is the wage value added in region i and industry j per unit of output j.

B_{jp} is the direct and indirect output generated in industry j per one dollar worth of output of industry p.

G_{pk} is the coefficient matrix of government expenditure organized by industry and program.

g_k is the dollar amount of government expenditure allocated to program k.

The expected income in region i generated by program k may be normalized by the population share of region i, thus,

$$(12)\quad r^*_{ik} = \lambda_i r_{ik} \quad \text{where } \lambda_i = \frac{p_i}{\sum_i p_i}$$

and where p_i stands for the population of region i.

Corresponding to r^*_{ik} there exists a c^*_{ik} which is an improvement or a deterioration in r^*_{ik} over the prevailing average r^*_{ik} per dollar spent on program k. The variance-covariance of the c^*_{ik}'s is given by

$$(13)\quad E(c^*_{ik}, c^*_{ij}) = V^*_{kj} \quad (k, j = 1, 2, \ldots, p).$$

The total regional return from all problems is defined by μ_R in (14) below:

(14) $\mu_R = \sum_{ijpk}\sum\sum\sum w_{ij}\ B_{jp}\ G_{pk}\ g_k \qquad (i = 1,\ldots,m).$

The variance in this regional return is defined as:

(15) $\sigma_R^2 = \sum_{ij}\sum (g_i g_j\ V^*_{ij}) \qquad (i,\ j = 1,\ldots,p).$

The problem resolves itself then into

(16) $\text{Min} \sum_i (\sum_j V_{ij} g_j)\ g_i$

s.t.

$\sum_i g_i r_i = \mu_R$

In matrix-vector notation

(17) Min $g'Vg$

s.t.

$r'g = \bar{r}$

Forming the Lagrangean expression

(18) $L = g'Vg - \lambda(r'g - \bar{r})$

we may be able to find g^o that minimizes (17) and satisfies the constraint $r'g = \bar{r}$ by simply differentiating (18) and setting the first order condition equal to zero. That is,

(19) $\frac{\partial\ (g'Vg)}{\partial\ g} = (V + V')g$

(20) $\frac{\partial\ r'g}{\partial\ g} = r\lambda$

Thus,

(21) $\frac{\partial\ L}{\partial\ g} = 2Vg - \lambda r = 0$

(22) or $Vg = \lambda^* r$

The conditions for the minimum are that g satisfies $r'g = \bar{r}$ and the set of simultaneous linear equations in (22).

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